THURSDAY, AUGUST 17, 1871

THE STATE AND THE INDIVIDUAL

TWO opposite views may be held as to the relation which ought to subsist between the Individual and the governing power of the State—views which, in their extreme form, may be expressed thus—the Paternal, in which the State does everything for the Individual, and the Independent, in which he is left to shift for himself in every respect, except protection from actual aggression by foreign or domestic foes. On the one hand, we are told that it is the duty of the State to have a paternal care over the morals and the welfare of its citizens; on the other hand, that the province of the Government is simply the protection of his person and his goods. To a certain extent both views are correct. The true function of the Executive Government may be laid down as the protection of the individual citizen, and of everything that belongs to him, against adverse influences that are not under his own control. A man's morals are his own concern, and the law has no right to interfere with them or to regulate them, any more than it has to interfere with his religion, provided that in carrying out his views of morality he in no way interferes with his neighbour's welfare or comfort. Then at once the injured party has the right of appeal to the assistance of the law to check his neighbour's aggressive morality or immorality.

Now the evils which a man may suffer from causes not within his own control are of two kinds—evils from his fellow-man, and evils from the forces of nature. Every Government acknowledges the right of its citizens to claim protection at its hands from the physical violence of others, whether foreigners or fellow-citizens. The whole of our military, naval, and police forces, and our criminal courts, form but a gigantic and enormously expensive machinery for securing this end. In the same manner our civil law-courts are designed as a security against the attacks of a man on his neighbour's pocket. But there are many other ways in which one man may suffer from another's misconduct, of which the State takes very little account, besides actually having his pocket picked.

To one of these we have recently alluded, in speaking of the loss of health which may be endured from one's neighbour's uncleanliness, or otherwise unwholesome mode of life. But, to refer more especially to pecuniary loss; if I wish to buy an article of a man, and send him the money, and he neglects to send me his merchandise, while pocketing my money, I have my remedy against him, if I can catch him, by a civil suit or criminal prosecution. If, however, he does send me something in exchange for my cash, but something that he knows perfectly well is not worth half the money, I am equally swindled; but my remedy against the cleverer rogue is extremely difficult, if I have any remedy at all.

A striking instance of the necessity for legislation in this respect is furnished by a report recently presented to the Royal Agricultural Society. The Agricultural Society employs a consulting chemist, the eminent Dr. Voelcker, whose business it is to analyse manures, feeding stuffs, and other materials sent to him by members of the society. The committee who have charge of this matter report that "they have to call the attention of the Council to the great number of inferior and adulterated manures and feeding stuffs sold to agriculturists, but that they hope that the determination of the Council to publish these reports will eventually do much to check such fraudulent transactions." Accordingly, here we have published analyses of manures, &c., in some cases with the names of the manufacturers or vendors attached, and including such items as the following:—"Carbonate and sulphate of lime, 48·77 per cent.;" "sand, 29·60 per cent;" "alkaline salts, chiefly sulphate of soda, 44·61 per cent.;" "a mere trace of ammonia, no phosphates whatever, a worthless mixture of green vitriol, crude sulphate of soda, gypsum, and sand, sold as the 'British Economical Manure,'" &c., &c.; many of these manures being warranted to contain a fixed proportion of organic matter, or sold as pure unadulterated phosphates. An oil-cake was found, on microscopic examination, to contain the husks of castor-oil beans, and to be totally unfit for feeding purposes; and this had already caused serious illness among the stock of several farmers.

So little dependence can be placed on the assistance of our complicated legal provisions in cases of this kind, that the only remedy suggested by the Agricultural Society is the publication of the names of the fraudulent manufacturers. Indeed, in one instance, the Society itself had to appear as defendant in an action for libel, and to pay nominal damages, while, at the same time, it was complimented by the judge on the benefit it was conferring on the community! Surely Justice was in this instance very blind.

There is no doubt that this publication, like the elaborate series of reports on the adulteration of articles of food published some years ago in the *Lancet*, will have exceedingly beneficial results, and high praise is due to the society for undertaking the work. But why should work of this kind devolve on any society or private journal? Why should individuals or private bodies be subject to the annoyance incidental to undertaking such a crusade? If it is the duty of the State to prosecute a man who picks my pocket in one way, why is it not the duty of the State to prosecute the man who picks my pocket in another way? The difficulties in procuring the necessary evidence might be greater, but would not be insurmountable. If it were impossible to summon in such cases a jury of experts to try the matter, any jury composed of men of business of ordinary intelligence would know how to value such evidence from a man of Dr. Voelcker's credit and experience, as that an artificial manure sold at 5*l.* 5*s.* per ton "would be dear at 2*l.* per ton;" that the "British Economical Manure" is "utterly worthless;" or that an oil-cake is "totally unfit for feeding purposes." If there is another side of the question, let us hear it; but as the evidence stands before us, there could be no difficulty in convicting these manufacturers of deliberate swindling.

Let us now turn to the cases in which a man suffers injury from the forces of nature beyond his own control. Here, again, there are certain principles acknowledged by the State; or rather, long precedent has sanctioned the application of principles in certain fixed directions, and in those only. No one will dispute that the Government is exercising its legitimate functions in building harbours of

refuge at great expense, in instituting a series of astronomical observations, and issuing an elaborate series of charts for the protection of mariners against the unavoidable risks and dangers of a seafaring life. The extent to which pure Science should be assisted by the State is still one of the grave questions for discussion of the day. But when we come to purely domestic, and especially to agricultural matters, few people seem to think that the State has any rightful authority here. Except the mariner, the farmer's welfare is more dependent on his knowledge of natural phenomena than that of any other class of the community. Who can calculate the enormously increased material gain to the country, were we able, from any series of meteorological observations, to predict with moderate certainty the weather for a week? Since the first dawn of agriculture, crops have been ravaged by insect enemies: "the palmer-worm, the canker-worm, and the caterpillar," have been the farmer's foes for the past three thousand years; and at the present day very little more is known of the causes of, or the remedies for, these plagues than in the days of Israel in Egypt. Our apples, our turnips, our hops, our vines, our potatoes, to say nothing of our gooseberries and our roses, are subject every few years to all but absolute destruction, and we are content to sit by idle, and to trust that next year will be a good year because this year has been a bad year. The continued existence among the farmers of some parts of England, of sparrow clubs, notwithstanding what has been written about the benefit conferred on the crops by these birds, is a standing evidence of the dense impenetrable ignorance in which the mass of our population is steeped.

In other countries they manage matters differently. Few can doubt that a laborious series of investigations as to the causes of and the best means of preventing the potato blight or the turnip-fly, aided by the light of the most recent discoveries in biology, such as M. Pasteur has conducted in the case of the silkworm disease in France, would be productive of most important results. We have before us the "Third Annual Report on the noxious, beneficial, and other Insects of the State of Missouri, made to the State Board of Agriculture, pursuant to an appropriation for this purpose from the Legislature of the State, by Charles V. Riley, State Entomologist." The report contains descriptions, with woodcuts, of the most pestilent insects of the State, of their mode of propagation, and of the result of experiments in different methods for their destruction; and others of the American States have annually granted sums of money for similar purposes, money which we cannot doubt has fructified hundredfold for the benefit of the thrifty western farmers. The Central Government of the United States publishes "Monthly Reports of the Department of Agriculture," containing an immense mass of information as to the progress of agriculture at home and abroad, the rearing of cattle, market prices, meteorological observations for the month, scientific notes, and innumerable subjects of interest and practical value to the farmer. Is it not worth consideration whether we might not spend a little of the public money that is now wasted in perfectly useless non-scientific experiments, to forward practical researches which have for their chief object the benefit of large classes of our fellow subjects, and the increase of the prosperity of the country at large?

MACNAMARA ON CHOLERA

A Treatise on Asiatic Cholera. By C. Macnamara, Surgeon to the Calcutta Ophthalmic Hospital. Pp. 557. (London: Churchill, 1870.)

THE literature of Cholera progresses with far greater strides than the scientific knowledge of Cholera. Here we have another large book devoted to the history of one disease, containing a digest of past information regarding the history, theories, and treatment of Cholera, and leaving us at the end with another theory of the disease, which is supposed to include the main practical facts in a useful form.

Discussions on professional matters are beyond our sphere, but as the subject of Mr. Macnamara's book is one of great public interest, especially at the present time, it may not be out of place to glance at it very briefly, from the scientific aspect of some of the questions dealt with by the author. The historical part of the work consists of statements and opinions of different writers of the most opposite kind. It is scarcely too much to say that these describe Cholera to be unquestionably contagious and as unquestionably non-contagious; that it is importable by ships and not importable; that its progress can be arrested by quarantine and that quarantine is a useless precaution; that it is communicable by clothing and that it is not so communicable; that it does and does not attack people living under the same unhealthy conditions; and that it can be cured by certain methods of treatment and that it can't be so cured. And then to crown the whole, we have theories of the disease which are as contradictory to each other as the facts. It appears to us that when we are confronted with evidence such as this, we can only arrive at one of two conclusions, either that the observations were one-sided and the logic wofully defective, or that there were reasons for the apparent contradictions requiring careful scientific study. Mr. Macnamara's own views about Cholera may be briefly summarised as follows:—

1. That the cause of Asiatic Cholera "is invariably a portion of the fomes of a person suffering from the disease." 2. That this must be in what is called the "vibrionic stage" of decomposition. 3. That it must be swallowed. 4. That it causes changes in the intestinal epithelium similar to its own, and that the epithelium is as it were washed off by the efflux of serous matter and passes away in the discharges. 5. That the organic cause of Cholera may be preserved dry for years. 6. That water is the most common medium of its diffusion, but that it may be carried and may act in foul air; and, lastly, the author says, "with the exception of the specific Cholera-infecting matter, I entirely ignore all other causes or combination of causes as capable of producing this disease." This last position, which is left unproved, is, indeed, the foundation of the theory. The theory is much the same as that put forward by Dr. Snow, Dr. Budd, Dr. Farr, and others, with a theoretical addition from another quarter as to the manner in which the poison acts.

The first remark which we would make is, that if there exists a Cholera germ, matter, *Cholerine*, or whatever else it may be called, its existence can be proved.

But the supposed pathological action of the matter, if it exists, may be considered as disposed of by Dr. Lewis's Report on the Scientific Inquiry into Cholera in India, in which he tells us "that the flakes and corpuscles in rice-water stools do not consist of epithelium or its *débris*." There being no *corpus delictum*, "Cholera infecting matter" cannot act in the way supposed. The whole structure falls to pieces whenever the light of scientific observation is brought to bear on it. We are thus left to deal with the other half of the theory, namely, the "Cholera germ," which is supposed by some to be of fungoid nature. But when we look for proof of its existence, we find only inference. The "fungoid" bodies which, by another modification of this theory, were supposed to be the agents in removing the epithelium, have been shown by Dr. Lewis to differ in nothing from similar bodies in healthy discharges, so that this fungoid theory has stood the test of observation no more than the "vibrionic" theory.

Instead of supplying the place of fact by inference or theory, would it not be better once for all to discard both, and try another method of arriving at truth regarding epidemic diseases? We agree with Prof. Tyndall as to the importance of physical research in such questions. Its methods are precise and rigorous, and by taking no cognizance of what is unproved, it may eventually do much in reconciling all the diversities of medical observation, and in opening out entirely new fields of investigation. Under the Government of India a most important scientific inquiry into Cholera is now being carried on in that country; and to all appearance the time is at hand when the most competent scientific men in Europe will have opportunities enough of dealing with the subject. Let the inquiry be strictly scientific. Let us refuse absolutely to admit anything of which we have not scientific proof, and we shall at least be able to divide between the known and the unknown.

Notwithstanding these criticisms on scientific points, Mr. Macnamara has written an interesting book which will well repay perusal. Amongst other things, he gives an account of the various practical sanitary proceedings which have been in use for mitigating attacks of Cholera.

Setting aside all theories about their action, it is satisfactory to know that with temperance in diet, attention to clothing, pure water for drinking and cooking purposes, and rigid cleanliness of towns, houses, and persons, as well as in ships, there is little to fear from Cholera epidemics. There is no theory needed to help us to understand these things. They simply require to be done. Volumes of instruction will not make the duty of doing them plainer than it is. These are, moreover, the things which are especially required for India, and we heartily second Mr. Macnamara's appeal to Lord Mayo, and to our present scientific Minister for India with which he concludes his work:—"The question for the consideration of the Government, is nothing less than this: Shall Cholera be allowed by our mismanagement or neglect to become permanently localised throughout the civilised world. It is to the condition of the inhabitants of the Gangetic valley that our attention and efforts must be primarily directed, if Asiatic Cholera is ever to be effectually controlled by human agency."

OUR BOOK SHELF

Papers on the Great Pyramid. By St. John Vincent Day, C.E., F.R.S.E., &c. (Edinburgh: Edmonston and Douglas, 1870.)

The Great Pyramid of Jizeh: the Plan and Object of its Construction. (Cincinnati: R. Clarke and Co., 1871.)

THE investigation of the history and origin of the Pyramids, and the attempt to arrive at the truths that are hidden in these, the greatest monuments of antiquity, is undoubtedly of the first importance, but must nevertheless be entered upon with caution. There is a danger about such a study which few seem to escape, a danger of being enslaved by some theory which becomes absolute master of the man who originated it, which makes him see everything through a false medium, and in support of which he perverts facts in the most marvellous manner. Mr. Day, the author of the "Papers on the Great Pyramid," has avoided the danger to this extent, that he brings forward no new theory of his own, but places his entire faith in Prof. Piazzi Smyth, the Astronomer Royal for Scotland, to whom this volume is dedicated. The papers are three in number; the first is a critical examination of Sir Henry James's "Notes on the Great Pyramid of Egypt," and would not have been written, the author tells us, had not Sir Henry himself opened and continued a correspondence with him on the subject, and had not he felt "the promptings of duty to expose fallacies so authoritatively flung into the midst of mankind." The two other papers are entitled, "The Measurements of the Great Pyramid recorded in history," and "An examination into the condition and works of mankind from the Creation to the building of the Great Pyramid." More than half of the entire volume is occupied by the first paper, and in it Mr. Day examines in the most minute manner every one of the eight "notes" he undertakes to controvert. He has succeeded in showing that Sir Henry James has been, to say the least, careless in his assertions, and even in his arithmetic, considering how positive his statements were. The general impression left upon the mind of the reader is that until the measurements of the pyramid have been ascertained without a shadow of doubt, no man has a right to base upon them positive assertions as to standards of length. Notwithstanding defects in his mode of treatment of the subject which it is hardly within our province to criticise, the book recommends itself to those who are interested in the Great Pyramid controversy, as it is evidently the result of careful study.

We also wish to notice in this place a small pamphlet on the Pyramid of Jizeh, which has come to us from across the Atlantic. The author does not profess intimate acquaintance with his subject, but acknowledging that such suggestions must be made with much reserve, points out certain relations he has discovered between the measurements of the pyramids and "time, extension, and earth space." They are certainly ingenious, but hardly, we think, much more. As illustrating what was said about the danger of indulging in such speculations, the author concludes by abruptly exclaiming that the fact of the English inch and English foot running "in such admirable rhythm with time and pyramid measure," may be a link of connection between the Anglo-Saxon and Hebrew races. Then plunging still deeper into this dangerous line of thought, he says, "were the blind eyes opened, it is quite possible that here in this new world of ours one would suddenly come to the realisation that he was dwelling in the midst of the teeming multitudes of Israel; terminating their emigration in a land long promised, long reserved; under government of a commonwealth restored; free from every taint of caste condition, or of kingly rule."

Although this pamphlet seems distinguished more by ingenuity than by any real value, it possesses the merit of being short, and is written with a reserve proper when dealing with such a subject. R. B. D.

Domestic Botany: an Exposition of the Structure and Classification of Plants, and of their Uses for Food, Clothing, Medicine, and Manufacturing Purposes. By John Smith, A.L.S., Ex-Curator of the Royal Botanic Gardens, Kew. (London: L. Reeve and Co., 1871.)

THE greater part of this thick volume consists of a brief description of the distinguishing characters of the most important orders of Flowering and Flowerless Plants, with a longer account of the more striking species belonging to each order which are cultivated in or imported into this country on account of their economical properties. The author's official connection with the Gardens at Kew gave him unusual opportunities for an acquaintance with plants of this class, and we do not know any work which contains so much useful and interesting information on the subject. Under the head of the Palm Family, for instance, we find no less than forty species mentioned, from which are obtained so large a proportion of the articles of food, dress, domestic use, and commerce, that supply the scanty needs of the inhabitants of tropical countries, cocoa-nuts, dates, oil, wax, toddy, sago, betel nuts, vegetable ivory, umbrellas, fans, &c. The book is, in fact, a repertory of information as to the history of articles derived from the vegetable kingdom. The work being evidently intended mainly for popular use, we doubt the wisdom of the word-coining so extensively adopted by the writer in structural definitions, especially as, in the preface, he refers to the deterrent influence on the study of botany, of the many technical terms with which other works on the subject abound. The following description, for example, of the habits of the Arum family, will convey but little idea to the general reader, even if the botanist can extract a definite meaning from it:—"Palmids, phyllacorms, epiphytal ampelids, or rhizocorm herbs, generally of a soft texture, destitute of pubescence."

We wish we could speak with equal praise of the earlier portion of the work, the "Explanation of the Parts, Structure, Life, Organism, and Classification of Plants." This has evidently been prepared too hastily, and not subjected, as it should have been, to a careful revision by some one familiar with at least the elements of Structural Botany, which would have prevented the use of such barbarous terms as "involucræ" and "phyllodæ," or such a definition as that "an ovary, with its pistil, is termed a carpel." These chapters by no means answer to their title of an "Exposition of the Structure and Classification of Plants;" a student trusting to them, instead of to one of the many excellent manuals already in existence, for his knowledge of structural botany, would be wofully misled; and the author has made a grave mistake in attempting a treatise on this subject. This is the more to be regretted, as the inaccuracies in the earlier part may deter the reader from proceeding to the main portion of the work, which is really useful and trustworthy. The coloured illustrations with which the book is adorned are very well executed; the woodcuts are on too small a scale to be of much assistance. Notwithstanding the valuable features of this book which we have pointed out, an exhaustive work on Economic Botany is still a desideratum in our literature, and one that would repay the labour of any one who possessed the needful information, and the power of putting that information into scientific and yet easily intelligible language.

A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his Correspondents. No notice is taken of anonymous communications.*]

Ocean Currents

I HAVE been watching with interest for some time past the discussions in your pages regarding Dr. Carpenter's theory. I have also read with much pleasure in your number for July 27 Prof. Wyville Thomson's excellent paper on "The Distribution of Temperature in the North Atlantic." In it he justly remarks that "what we expect of Dr. Carpenter before we are called upon to accept to the full his magnificent generalisation is a calculation and demonstration of the amount of the effect of the causes upon which he depends, acting under the special circumstances." And he further adds, that he has several times put the question to specialists in such physical inquiries, but they have always said that it was a matter of the greatest difficulty, but that their impression was that the effects would be infinitesimal.

I have examined this subject with great care, and may be permitted to say that, in so far as the point at issue is concerned, the problem, if properly treated, is by no means difficult, but on the contrary is one of great simplicity.

Taking Dr. Carpenter's own data, I have, in regard to the Gibraltar Current and to his General Oceanic Circulation, determined the absolute amount of those effects on which his circulation depends. Taking a given quantity of water, say one pound, placed under the most favourable circumstances, according to his theory, I have determined, first, the absolute *force* of gravity acting on the pound of water tending to produce motion, and, secondly, the absolute amount of *work* which gravity can perform upon the pound during its entire circuit.

I can form, of course, no estimate of the amount of the work of the resistances to the motion of the water along its course. But, imperfect as our knowledge is on this point, we can nevertheless easily satisfy ourselves that the work of the resistances greatly exceeds the work of gravity, and that, consequently, there can be no such circulation as that for which Dr. Carpenter contends.

My results are embodied in a rather lengthy paper on the subject, the publication of which has been delayed, owing to circumstances over which I have had no control; but I expect that it will appear in the *Philosophical Magazine* for October next.

Edinburgh JAMES CROLL

The August Meteors

HAVING been engaged during the past week in observations on the August Meteors, I thought a few of the results might be interesting to some of your numerous subscribers. My regular observations extended from Sunday night to Friday night; and, as the following table will show, the weather was, with the exception of one night, as favourable as could reasonably be desired. From over 120 meteors mapped down (out of about 330 seen) it is evident that the principal radiant point, or rather line, is a line drawn from α Persei to γ Persei, and onwards towards η. One bright meteor was seen on the 8th, just below η Persei, which did not move more than $\frac{1}{2}°$ in a second of time, and left a *cloud* behind it lasting about two seconds. A remarkable feature was the *outlying* radiants, as they appeared to be, one of which was situated at or near θ Cassiopeiæ, another near the star *c* of Camelopardalis. The radiant situated between δ Cygni and γ Draconis is very well marked; also a radiant near γ Cephei (where another almost stationary meteor was observed); and one just below ϵ Pegasi, towards α Aquarii; associated apparently with the last is a radiant near the small lozenge in Delphinus, above α Aquilæ.

In the list below of 312 meteors observed here, 242, or about 77 per cent. were from the Perseus radiant or radiants:—

Meteors seen August 1871, at York.

Date.	Hours.	State of sky.	No. observed.	Do. from Perseus.	
					Proport.
5th	10. 0—10. 10	Fine.	6	5	·83
6th	10.20—12. 0	do.	34	28	·82
7th	10. 0—12. 0	do.	49	30	·61
8th	10. 0—12. 0	do. till 11 45 then cloudy.	50	31	·62
9th	10.30—11.30	Cloudy and hazy	6	4	·6
10th	9.55—12. 5	Few clouds at times, and very slight haze.	120	106	·88
11th	do.	do.	47	38	·80

Generally two watching, sometimes three, and once or twice but one. For the 10th I had a list of twenty-six others handed me, observed by a friend close at hand, of which nineteen were from Perseus.

20, Bootham, York, Aug. 14 J. EDMUND CLARK

Daylight Auroras

I HAVE frequently seen the appearances described by Mr. Winstanley in your issue of August 3, and I think I must have seen the one he mentions. I have on two occasions watched similar phenomena caused by the moon. These phenomena require the cloud or clouds, from which they are formed, to be of about the same azimuth as that of the sun (or moon), and vary with the form and motion of the cloud, being, I think, simply a deflection of the sun's rays from the more salient points of the cloud. The streamers I saw on June 27 (see NATURE of July 9) were of an entirely different nature, rising near the south horizon somewhat to the east of the meridian, and flashing towards the moon, which had recently passed the meridian, while the sun was near setting in the N.W.

I have had nearly thirty years' experience in observing, and have no doubt that what I described were true streamers of an aurora australis. JOHN LUCAS

Radcliffe Observatory, Oxford, Aug. 17

The Late Thunderstorm

THE thunderstorm which has just broken up the spell of hot weather for the past week presented some peculiar features as seen from this place. Commanding rather a wide horizon, I noticed about 8.30 last evening two distinct centres of disturbance, one S.W., the other N.E. It is impossible to estimate the distance by sound, as the thunder was inaudible. The electric spark, however, was visible enough, and I noticed that with one exception it went invariably from S. to W. in the one case, and from N. to E. in the other, and always horizontally from cloud to cloud. When I came out again at 10.15 I found the two centres had moved, so that one was slightly S. of E., and the other N. of W., but still directly opposite each other. It seems, too, that they had gone in the direction in which the electric spark had passed.

This seemed to me interesting, and I thought your readers might find it so too.

Upton-on-Severn, Aug. 14 W. M. ROBERTS

Sir William Thomson and the Origin of Life

I AM sure that Sir William Thomson will feel gratified rather than annoyed to be informed that he has been anticipated in his remarkable hypothesis regarding the origin of life on our globe.

In a very curious book called "A Visit to my Discontented Cousin," published some months ago, there is a portion of one chapter headed "The Aerolite." The "Discontented Cousin" having seen and heard a discussion on a meteoric stone, went home and "dreamt a dream," in which he saw the surface of the mass undergo various changes, and organic dots appear, one of which began to wriggle, rose to its microscopic legs, and confronted "the dreamer with a bold and self-confident mien."

This microscopic man, after having enjoyed "a glass of something stiff and a pipe," told the story of his own planet, beginning with the not very complimentary remark, "We know all about you, old boy, and the British Association; and we don't think much about you, either."

For the story itself I must refer to pp. 186-192 of the book.

Torquay, Aug. 8 G. E. D.

Meteorology at Natal

IN your issue of November 10 last I was glad to see that you were alive to even humble efforts to assist science in so distant a place as Natal by your remark on the new Meteorological Observatory for the Durban Station.

As it may be interesting also to know what has been done, I append a list of the instruments ordered by the Natal Government. They are to supplement a few already on board. Unfortunately for the furtherance of this object, the state of affairs at present will not admit of any large expenditure of public money in this direction, but I have been enabled to get the sum of 10*l.* in 1870 and 25*l.* in 1871 for the purchase of instruments. The Government, at the same time, pay the observer 12*l.* per annum for the trouble of registering the results regularly.

At present the military authorities have an observatory at Fort Napier, in Pietermaritzburg, at a height of 2,200 feet above and forty-five miles from the sea. A station on the coast was required to complete the observations, and the Government liberally came forward with the means. Hitherto a system of registration has been followed in which the instruments were suspended in wooden boxes against the sides of dwelling-houses. Though such a system, perhaps, is advisable as giving the temperature ordinarily felt by residents, it nevertheless is more or less uncertain for the purposes of comparison, from the fact of some of the dwellings being built of wood and others of stone, and again some roofed with slates and others with galvanised iron.

The present system is that pursued by the military authorities. The thermometers are placed under a Glaisher's stand in the open air. Whether the military authorities are right or wrong matters little so long as one universal system is pursued, so that exact comparison can be made between each station. The results will always be sent to the Meteorological Society of England, and published in the Colonial Blue Book for each year.

VINCENT ERSKINE

Pietermaritzburg, Natal, May 16

P.S.—I expect the Observatory to be in thoroughly good order from the 1st of January, 1872.

On the Colours of the Sea

THE following is submitted on the above subject, referred to in NATURE of July 13, as showing that the colour of the sea is not altogether dependent on the purity and depth of the water. At Zante, and southward as far as I have seen, it is of a deep blue at midday, but in the evening it is that described by Homer as "wine-like." I have observed this particularly when passing Navarino and Cape Mataplan. At night, looking down upon it from the steamer, it is quite black, lighted up, where the waves are broken, with white phosphorescent light.

I had once the gratification of seeing the whole of the solar spectrum spread out upon the sea, at Zante, on December 26, 1861. The weather was very unsettled at the time. During an interval, when the rain had ceased, a little before 10 A.M., the light of the sun descended from behind a cloud, and was reflected up to the height on which I was standing. Purple was the most remote colour; red the nearest; the space between was occupied by the other colours, of which green, yellow, and blue were the most marked. JOHN J. LAKE

Origin of Cyclones

IN NATURE of 23rd of June, 1871, there is an account of a paper, by Mr. Meldrum, on the origin of storms in the Bay of Bengal, showing reason to believe that the cyclones of the Bay of Bengal and the Southern Indian Ocean originate in the meeting of the trade-winds of the northern and southern hemispheres at some distance north or south of the equator. I do not know of any equally complete evidence on the subject for the cyclones of other parts of the world, but there is very strong reason for thinking that they always so originate. The line along which the two trade-winds meet each other approximately coincides with the equator: when it actually or nearly coincides with the equator, no cyclones are formed, because the rotation of a cyclone depends on that of the earth, and the earth at the equator has no rotation round an axis drawn vertical to the horizon. Over the greater part of the Pacific, cyclones do not appear to be formed: the reason of this probably is, that in consequence of the temperature of the sea changing but little with the seasons, the two trade-winds over the Pacific meet each other nearly on the equator all the year round; though I do not know how far this is confirmed by observations on the winds of that ocean. But we know that in the Indian Ocean the trade-winds cross the equator and are deflected into monsoons, so that in the summer of the northern hemisphere they meet to the north of the equator, and in the summer of the southern hemisphere they meet to the south. (This statement as to seasons will have to be qualified presently.)

We may consequently expect to find that the farther the sun is from the equator, the farther from the equator will be the meeting of the trade-winds, and consequently also the cyclones. This is the fact. In Dove's "Law of Storms," translated by Mr. Scott, at page 193, there is a chart of the tracks of the cyclones of the Chinese Sea, which shows that they occur in all months from June to November, and that the later in the season the nearer to the equator is usually their track. In the Chinese Sea, where they are called typhoons, they are most numerous in the summer months; in the Bay of Bengal they are most numerous after the equinoxes. This will appear

quite intelligible if we regard the cyclone region of the Chinese Sea as an extension of that of the Bay of Bengal; it will then be seen that the cyclones follow the sun. This, however, must be understood with the qualification that they follow the sun at some distance; the number of cyclones in the Indian Ocean appears to reach its maximum a month or two after the equinoxes. This is for the same reason that the warmest period of the year is not at but after Midsummer.

The distribution of cyclones in the West Indian Seas is to be explained in the same way. The two trade-winds meet in the Atlantic a little to the north of the equator; for this reason cyclones are frequent in the West Indies but unknown over the South Atlantic, and they are most numerous at the end of summer. JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim

Saturn's Rings

AN absence in the country prevented my seeing Lieut. Davies's letter in time for an earlier reply. I will answer him on all points, and have done with him, for he employs unfair arguments to impeach me.

1. I defy him to point out the smallest word or slightest expression in my remarks on his work that justifies him in asserting "that I commenced my notice very much under the impression that Prof. Clerk Maxwell having investigated the stability of Saturn's rings, no one else is to venture into any discussion on their nature and origin." I never for a moment entertained, much less expressed, such a thought. I simply pointed out that Prof. Maxwell had shown rings of satellites to be the only ones which could exist, and I said merely that Lieut. Davies, "having espoused this theory, had sought an explanation" of it. Lieut. Davies's allusion to a *caveat* is therefore an empty flourish.

2. Lieut. Davies says I "assert" that he has not seen Prof. Maxwell's work. This is an unpardonable misstatement. I said he "appears not" to have seen the work; and I was driven to this assumption, since Lieut. Davies, while actually using Maxwell's labours, never mentions his name. Certainly he is at liberty to choose his own starting point: but he should credit the well and not the bucket (Mr. Proctor will pardon me) for his inspiring draught.

3. As to faith in figures. I take for granted that no rational man would publish numerical data unless he believed his figures really to mean what they stand for. Now, the rate of the solar motion is not known to within a thousand miles an hour, and the solar parallax is only certain to the first place of decimals. As Lieut. Davies prints the first of these data to a mile, and the second to four decimal places, he has clearly too great faith in figures. He may say that "other observers" (why observers?) do the same; that does not excuse him. Further, a different rate of solar motion must alter his spirals; if there were no motion he would have no spiral.

4. I know that "very clever men" have held the meteoric theory of the sun, but I also know that "very clever men" have held other theories. Lieut. Davies, in denying my assertion that he is "blindly enraptured" with the meteoric theory, actually supports me; for when he says that "none of the modern theories, 'cumbrous vagaries of the brain,' can compare with it," it is clear that he cannot see the fairness of any crow but his own, and this is blind infatuation.

5. Either we are not agreed upon the meaning of "cyclonic," or Lieut. Davies is sun-spot blind. I call such a spot as that reproduced on page 232 of Mr. Proctor's book "cyclonic," and I have seen many, both on the sun and in drawings, of this character. Lieut. Davies's range of observation must be limited if he has not seen some also. Mr. Carrington's work is quite beside the question; he did not delineate spots, he merely measured and counted them.

YOUR REVIEWER

Extinction of the Moa

THE very interesting article on the Moa in your issue of July 6th by Dr. Hector adds considerably to the facts already ascertained as to its existence along with man, and also as to the probability of its recent disappearance. Visiting in 1866 and 1867 many of the places mentioned by the Doctor in the Middle Island, I had opportunities of seeing portions of their remains in various conditions, either in caves, river sides, or in the open country where cultivation was going on, or on the sides of the hills in the interior, and certainly the impression produced was, that not perhaps more than fifty years had elapsed since some of the remains had formed part of living birds.

On the Kourow range of hills in the north of Otago, I saw Moa bones and those of a wild pig in close proximity; and, though certainly those of the former were more weathered, taking into consideration the greater density of the latter, it did appear as if there had not been a great many years between the deaths of each. I have also some bones in my possession, and there are others in the Geological Society's Museum in Edinburgh, found on the surface of the Carrick ranges, a place alluded to by Dr. Hector, the unexposed portions of which do not seem very aged. While agreeing with Dr. Hector that there is reason to believe that the last of the race have only of late disappeared, viewing the question from the point of an agriculturist, I differ somewhat as to the causes. He says that the facts he adduces "afford strong evidence that the bird has been exterminated by human agency, though the race was expiring from natural causes." It seems to me that in such a country as New Zealand their loss has arisen from natural causes, though the Aborigines may have assisted somewhat to diminish their number. Dr. Hector admits that there are still portions of Otago where the foot of man has scarcely trod, notwithstanding the search for gold, perhaps the most eager which can exist. The Moa had these districts to retire to. In the Middle Island very few Maories dwelt, and their numbers were kept down by the forays of the more warlike inhabitants of the North Island. The pigs, supplied to the natives by Captain Cook, have spread over the island and increased largely, and have only been prevented from still further increasing by the use of the musket and the occupation of the country by the settlers. While the Kiwi still maintains its place, it is hard to believe that man has exterminated the Moa. The natural causes, however, it seems to me, are quite sufficient. Dr. Hector speaks of large fires having spread over the centre of Otago. It would appear that the pine woods, which have covered so many of the hill sides of the interior, had reached a certain state of decay, and, from the occurrence of droughts less severe than those of Australia, perhaps, fires lighted by the natives had spread to these woods, and though an undergrowth of fern and moss might retard the progress when once the pine timber, with its resinous qualities, thoroughly caught, there was little chance of it going out save from breaks caused by rivers or bare places. As these fires spread over the interior, destroying everything in the shape of bush or tree, the native grasses took their place, none of which seemed to me to afford fitting food for such a bird, and with these grasses a plant called by the native Tutu occupies much of the country. The leaves of this plant are, under certain conditions, destructive to live stock; while the berry which it produces may be eaten with impunity, provided the stone it contains be not swallowed; the settlers making a wholesome jelly of the pulp, and sometimes wine. Here, then, we have a vast portion of the country cleared of its food supplies, from the trees and shrubs which produced it being destroyed, and we have a poisonous plant abounding, which does not grow freely under wood. Dr. Hector speaks of counting thirty-seven skeleton heaps of Moas on the side of the Wakatipu Lake, and supposes that they had been driven there by fire. This may be so, but I have seen a great many similar heaps, in the centre of each of which two or three handfuls of quartz pebbles lay on the flat alluvial lands on the sides of streams and near the seashore, where beds of gravel then were, to which the birds could have retired, had they been pressed with fire, as no vegetation could have existed there. It therefore seems to me that the reason why so many skeletons are found on the surface near streams or water, arises from the fact that these creatures, pressed by hunger, partook of the Tutu berries, and that thirst, which so often accompanies poisoning, caused them to take to such places for drink. I have heard it stated that in periods of drought the Emus of Australia travel great distances for water. Though water is far more abundant in New Zealand, it is often only in the streams that it can be had. JAMES MELVIN

NOTES

THE following is the programme of the subjects to be submitted for discussion at the International Congress of Anthropology and Archæology, to be held at Bologna from the 1st of October next:—The stone age in Italy; 2. The caverns of the shores of the Mediterranean, especially of Tuscany, compared with the caves of the south of France; 3. The lake habitations

and mounds of the north of Italy; 4. Analogies between the Terrawaris and the Kjoekenmoeddings; 5. The chronology of the first substitution of iron for bronze; 6. Craniological questions relative to the different races which have inhabited the various districts of Italy.

DR. BENJAMIN T. LOWNE has been elected Lecturer on Physiology at the Middlesex Hospital School of Medicine.

THE Society of Civil Engineers of Paris has just elected as its president for the coming year, M. Yvan de Villarceau, the chief astronomer of the Observatory, and has conferred the title of honorary president on M. Tresca, vice-director of the Conservatoire des Arts et Métiers, as a testimony of high admiration for his conduct during the siege of Paris, and under the reign of the Commune.

WE understand that it has been decided to erect a statue to Sir Humphrey Davy in his native place, Penzance. By the exertions of a working committee, a sum of 500*l*. has been raised in subscriptions. A very eligible site has been obtained from the Town Council immediately in front of the Market-house and facing the main entrance of the town. The Messrs. Wills, of 172, Euston Road, have been commissioned to execute the statue. The statue is designed after Sir Thomas Lawrence's portrait, painted for the Royal Society. The total cost of the statue and of erecting it on the site provided is estimated at 600*l*.

A PORTION of the surplus funds from the International Horticultural Exhibition of 1866 was invested in trustees and applied to the purchase of the botanical library of the late Prof. Lindley, to be called the Lindley Library, and to serve as a nucleus of a consulting library for the use of gardeners and others. Considerable additions were made to the library by gift, a catalogue was prepared, and the books deposited in the rooms of the Royal Horticultural Society at South Kensington, but here the matter was allowed to lie dormant for a considerable time. The trustees have now just issued a circular, stating that the library is now open for the use of the public under certain regulations. Fellows and officers of the Horticultural Society have access to the library at all times when it is open, gardeners and others not fellows or officers of the society by application to one of the trustees, or to the assistant-secretary of the society. Under certain restrictions those using the library can have the books out on loan; and, as it contains a very large number of standard botanical and horticultural works, it is hoped it may be of great practical service. The trustees will be very glad of assistance in completing imperfect sets of periodicals and works published in parts, and in adding recently published treatises, for which the funds at their disposal are quite inadequate.

THE *American Naturalist* states that among the signs of the scientific life of the present day in that country, one of the most encouraging is the increasing frequency and enthusiasm of those delightful occasions of scientific study, intercourse, and recreation, called field meetings.

AT a meeting of the Faculty of the Museum of Comparative Zoology of New York, held May 6, 1871, the Humboldt Scholarship was awarded to J. A. Allen, in consideration of his paper upon the "Mammals and Winter Birds of East Florida," and the proceeds of the Humboldt Fund for one year were granted to him in aid of his exploration of the Fauna of the Rocky Mountains.

HERE is a transatlantic hint to our scientific colleges and schools:—Mr. Albert H. Tuttle has been appointed instructor in the use of the microscope at Harvard University.

WE find in the *American Journal of Science* for July a more detailed statement of the result of the Williams College expedition than has heretofore been published. This consisted of five members of the present senior class, under the leadership of Mr. H. M. Myers, who gained much experience in the line of exploration in connection with the Venezuelan branch of Professor Orton's expedition of some years back. We have already referred to the movements of this party, and it is only necessary to add that large numbers of birds were obtained by the expedition at Comayagua, as well as two statues, exhumed at Chorozal, south of Belize. The collections made by the party will go to enrich the Williams College Lyceum of Natural History, and will add much to its already extensive treasures.

THE late Mr. James Yates, M.A., F.R.S., has left 200*l*. to the Geological Society, and 50*l*. to the Linnean, and 100*l*. to Prof. Levi towards the adoption of a universal decimal system of weights, measures, and coins, in addition to the large sums of money devised to University College, London, towards the foundation or augmentation of professorships in mineralogy and geology and of archæology. To the same College he leaves all his books on mineralogy and geology, together with his specimens and his collection of ancient coins and other antiquities.

THE Sub-Committee appointed by the Asiatic Society of Bengal to consider the desirability of undertaking Deep Sea Dredging in Indian waters, have presented a memorandum on this subject, signed by Thomas Oldham, Ferd. Stoliczka, and James Wood-Mason. After recapitulating the important results which have accrued from European Dredging Expeditions, the Sub-Committee state that they are confident that explorations of the Deep Sea in Indian waters will not only furnish data which will illustrate the modification of certain supposed laws regulating animal and vegetable life in countries geographically and climatologically different, but that they will undoubtedly supply much and most important material for the study and explanation of many yet obscure facts in zoology, geology, physics, and the collateral branches of science. They, therefore, earnestly hope that Government may be led to regard the undertaking of Deep Sea Dredging in Indian waters as the most important source whence great progress to natural history and physical science will result. The Committee suggest the examination of the Bay of Bengal by a line of dredging right across from new Juggurnath Black Temple to Cape Nagrais, to be followed by another transverse from near Madras to the Andamans or the Nicobars, and again by a line from Ceylon to the coast of Sumatra. It would be necessary that, say three persons acquainted with the mode of inquiry should accompany each expedition, and it is hoped that sufficient accommodation could readily be found for them on board. They then describe the apparatus that would be required, and state their belief that an annual grant of 2,000 Rs., placed at the disposal of the Dredging Committee, would be sufficient for the objects desired.

MR. THOMAS BLAND, who has long studied the land shells of the West Indies, is now endeavouring to elucidate their distribution by the help of the depth of the sea between the different islands. The materials are as yet imperfect, but in a paper read before the American Philosophical Society in March 1871, he announces that the depths so far as known agree with the distribution of the various groups of shells. He finds that the whole West Indies may be divided by a line south of Santa Cruz and St. Bartholomew, and north of St. Christopher and Barbuda, and that all islands south and east of the line show an affinity to Venezuela and Guiana in their shell fauna, while those to the north and west of it are similarly allied to Mexico. All the southern islands, as far as St. Vincent, are situated on a submerged bank of about 2,000 feet deep, extending from the main land of South America, and these all possess shells of a more especially continental character than any other part of the West Indies. Some very interesting results may be expected

when the sea bottom of the Gulf of Mexico shall have been more accurately surveyed.

THE last Report of the Juvenile Literary Society of the Friends' School, Croydon, shows that natural history is in no way neglected by the members. Twelve boys have been collecting British plants, two collections are being made to illustrate botanical terms, and two to exemplify the British natural orders. Nearly three hundred "varieties" (? species) of plants in flower have been exhibited in the school-room, and some additions to the flora of the district have been discovered. Observations on the weather and the recurrence of natural phenomena have been kept up; and collections illustrating the ornithology and conchology of the district are in progress. Additions to the library and museum are acknowledged, and the treasurer's report shows a balance in hand.

THE Transactions of the Maidstone and Mid-Kent Natural History and Philosophical Society for 1870 are chiefly remarkable for their total want of local matter. Papers are printed on "Sericiculture," "The Nervous System," "Skin and its Appendages," "Natural Selection," "The Similarity of Various Forms of Crystallisation to Minute Organic Structure," and "The Geometrical Structure of the Hive-Bee's Cell," none of them containing anything new, although of average ability; but we look in vain for any information as to the fauna or flora of the district. Classes in connection with South Kensington in Mathematics, Electricity and Magnetism, and Inorganic Chemistry, have been established, and the number of members is on the increase.

WE learn from the *Melbourne Argus* that the past efforts of the Acclimatisation Society, and of private individuals working with similar objects, have been only too successful. Rabbits and sparrows are now so abundant that in many districts they are a complete nuisance, and vigorous efforts are being made to extirpate them, or at any rate to reduce their numbers. Hares are so numerous in the neighbourhoods of Melbourne and Geelong that it is proposed to modify the restrictions hitherto imposed upon their destruction, and to allow clubs, upon payment of a moderate licence fee, to course them.

THE account which has been published of the terrible ravages caused by the plague in Buenos Ayres, reads like so many pages from the description of the Great Plague in London. During the months of March and April last the city was almost entirely deserted, everyone who could fleeing into the country. The deaths increased from the daily average of 120 in January to 640 on the 4th of April and 720 on the 5th, whilst on the 6th of April 500 entries at the cemetery were registered up to noon. From this time, owing to the exodus of people, the ravages of the plague began to diminish, and there is every reason now to hope that it may soon be stamped out. In one cemetery alone 20,000 corpses were buried, and for this purpose large trenches were dug, in which the bodies, some coffined, but many merely swathed in their bed clothes, were shot out of carts and quickly covered with lime. Attempts of all sorts were made to stay the plague, but unavailingly, and whilst the native doctors fled the spot, to the credit of the few English medical men there, it is universally allowed that they worked most nobly and disinterestedly through all the terrible time. We read of "coffins being hawked about the streets, while empty carts touted for their silent passengers; of people stricken with fever deserted by their friends and relations and even their children, and left to die without medical attendance or even food and water; of the shrieks and cries of delirious patients that made night hideous; and of the corpses that were constantly found by passers-by in the early morning of people who had been seized with the death agony in the streets during the night time." The cause of all this horror and misery is described as purely local, and due to the total absence of drainage and the terrible overcrowding of the houses and localities where the poor reside, and the long continued neglect of the most ordinary sanitary precautions. Surely this is a terrible lesson to those who wilfully and criminally neglect the reiterated teachings of science.

A SINGULAR instance of canine madness in a horse is recorded in a recent number of the "Zeitschrift für Parasitenkunde." A horse which had been some time before bitten by a dog supposed to be mad, was brought to the hospital of the Royal Veterinary College at Berlin, suffering from an uncontrollable propensity to bite, not only men and other animals but any hard substance, and even its own body, by which it had severely injured its mouth and broken several of its teeth. After its admission to the hospital, this propensity was violently manifested in fits, preceded by remarkable convulsive movements, after which it would fall suddenly, and remain for a time perfectly motionless, becoming gradually weaker after each attack. It had refused food for two days, and died without a struggle on the evening of the day on which it was admitted. An examination showed no organic disease, but considerable internal inflammation.

WE have received from Prof. Hinrichs, of the Iowa State University, U.S., the first two numbers of the *School Laboratory of Physical Science* edited by him. The object is to supply a defect stated in the prospectus to be as flagrant in America as it is in England, that their schools, while very excellent in regard to the literary branches, neglect nearly all departments of science. The numbers which have already reached us contain original articles on Physical Science, laboratory notes and news, chronicles of observations, and reviews of books. They are illustrated by lithographs, and published at a low figure. We commend the publication to all those interested in the progress of Physical Science in America, and anxious to further the same. We may add that the publication is maintained at a considerable loss to the editor, and it is doubtful whether it can be carried on unless it receives the extraneous support which it so well deserves.

A TERRIBLE and most disastrous tornado is reported from Dayton, Ohio, U.S., on the 9th of July, by which eight people were suddenly killed and more than fifty seriously injured. The damage done to property was immense, hundreds of houses and churches were unroofed, bridges were carried away, trees were lifted up by their roots, and locomotion of all kinds was stopped, and in the country very large quantities of wheat and grain were completely ruined.

SINCE we noticed the appearance of the first part of Messrs. Sharpe and Dresser's "History of the Birds of Europe" (NATURE, April 27), three more parts have appeared, each containing eight or nine beautiful plates, and the usual copious letterpress. Among the former we may notice those of the pigmy owl (*Glaucidium passerinum*), the white-tailed lapwing (*Chettusia leucura*), the great black woodpecker (*Dryocopus martius*), and the red-backed shrike (*Lanius collurio*), as being especially admirable pictures of bird life; while the fact that twelve pages of letterpress are devoted to the bearded reedling (*Calamophilus biarmicus*), fourteen to the great black woodpecker, and the same to the hobby and eider duck, will give some notion of the labour and research devoted to bringing together all the reliable evidence on the habits, distribution, structure, and affinities of the several species. Instead of making the pictures everything, as has sometimes been done in illustrated works on natural history, we have here really a "history" of all the more important known facts relating to each European bird. We sincerely hope that a work which the authors evidently spare no pains to make as good as possible, may meet with the liberal support it deserves.

WE understand that the eruption of Mount Vesuvius, which has been more or less continuous during the past six months, and which has lately increased considerably in violence, is

causing great apprehension as to the safety of the Italian observatory of Vesuvius. The lava has already partially submerged the hill of the Canteroni on which the observatory stands, and the immediate erection of a strong dyke of scoria so as to divert the stream of lava is urgently asked for.

WE are requested to state that the terrible earthquake at Bathang in China, of which we lately published an account (NATURE, vol. iv. p. 45), occurred on April 11, 1870, and not this year, as might be inferred from the description.

THE American Polar Expedition in the steamer *Polaris* (Capt. Hall) left Brooklyn on June 29th. Dr. E. Bessels, of Heidelberg, who was Scientific Director of the German Expedition to Nova Zembla in 1869, is appointed to the same position on this expedition. The vessel is provisioned and equipped for two-and-a-half years' absence, but the explorations may be continued longer if Capt. Hall desires it, and fresh supplies will be sent. The expedition is undertaken principally for geographical discovery, but every opportunity will be made use of to make scientific observations and experiments, for which purpose a long series of instructions have been drawn up by a committee of members of the Academy. These consist of Prof. Henry on meteorology; Prof. Newcomb on astronomy; Prof. Higlard on magnetism; Prof. Baird on natural history; Prof. Meek on geology; Prof. Agassiz on glaciers. Orders have been given that small copper cylinders containing letters, scientific intelligence, &c., shall be frequently thrown overboard during the progress of the expedition, and these, when found, are to be sent to the Navy Office and afterwards published.

A MOST important discovery is announced from the Isthmus of Panama. In the district between Aspinwall and Panama, and extending over a large area, valuable beds of coal have been discovered and recently fully explored. The quality of the coal has been tested and most favourably reported on. These mines can be worked to great advantage, and the seams are rich and extensive, and there is ample water communication to the coast by means of the river Indis. If further investigations confirm this preliminary report, great benefit cannot fail to result to commerce in the Atlantic and Pacific Oceans from this opportune discovery.

THE GUN-COTTON EXPLOSION AT STOWMARKET

THE disastrous explosion of gun-cotton, which occurred on Friday last on the premises of the Patent Safety Gun-cotton Company, is a calamity of unusual significance. Besides the large number of killed, amounting, we believe, to five-and-twenty persons in all, there were as many as seventy maimed and injured, many of them too, in such a manner as only violent explosions are known to torture and lacerate their victims; and when it is taken into consideration that in all probability a dozen tons of the material actually exploded, the grave nature of the accident is in truth not surprising. The whole group of factory-buildings and out-houses were levelled to the earth at one fell swoop, and for miles away the effect of the catastrophe was acutely felt.

But it is not only from a social point of view that the affair is to be deplored. As a result seriously affecting the science of explosives, the occurrence is peculiarly unfortunate; for the belief in the safety of gun-cotton as an industrial and military agent will now be gravely shaken. It is all very well for scientific men to adduce a plausible reason for the occurrence, and to prove conclusively that with due care and precaution a disaster of this nature could not possibly have happened; but the public unfortunately will not be satisfied with a theoretical assurance of this kind; and indeed measures should certainly be taken, not only to guard against such wholesale death and destruction, but to render the same absolutely impossible.

The true cause of the disaster we can scarcely hope to discover; but, leaving out of consideration any personal carelessness on the part of the workmen, the ignition of the cotton must either have occurred through the accidental firing of a cartridge, or primer, or through spontaneous combustion. It is well known that pyroxilin may be exploded in two totally distinct ways—that is to say, either by inflammation or detonation. In the first instance the cotton, unless confined, only burns fiercely, and does not explode like gunpowder on the instant; while, on the other hand, if it is ignited by detonation or percussion, the material acts in the same violent manner as nitro-glycerine or fulminate powder. Is the catastrophe at Stowmarket, then, the result of detonation, or of the milder form of explosion, such as inflamed gun-cotton confined in lightly-built magazines would produce? If sporting cartridges, such as contain a small charge of fulminate or detonating primers, were at all near the spot, the culpability of the authorities is very great indeed; for the approximation of the two agents constitutes obviously a source of extreme danger, and it is really hard to believe that so thoughtless a proceeding could have been possible. At the same time, if a detonation actually did take place, as in fact some of the results would lead us to believe, then there is no other way of explaining the occurrence.

In regard to the theory of spontaneous combustion, we must not be too eager to draw conclusions, as the careful experiments recently made by Prof. Abel distinctly prove that decomposition in this wise is almost impossible, provided the pyroxilin has been carefully manufactured. Truly, if such has not been the case, and there existed impurities or imperfectly converted masses in the store of gun-cotton at Stowmarket, then a valid reason for the explosion is no doubt at hand. Still it must be remembered that pyroxilin only takes fire at a high temperature (300° or 350° F.), and therefore we must suppose that not only was the recent hot sun allowed to shine uninterruptedly upon the magazines, but that the latter were, moreover, very badly ventilated, and altogether ill cared for. Again, to have produced such wide-spread devastation, the stores or outbuildings containing the cotton must have been somewhat strongly and firmly built, otherwise there would have been no resistance to the burning mass, and consequently no violent explosion, for it must be borne in mind that the more completely the charge is confined, the more energetic will be the result.

Under any circumstances, then, we must come to the conclusion that either the gun-cotton was strongly confined in cases or magazines and simply inflamed, or that the material was detonated by a charge of fulminate powder; and in whichever way the accident happened, the same was in great measure due to neglect and carelessness. Why, indeed, such a large store of dry gun-cotton should have been kept so near a populous factory it is hard to understand; and inasmuch as the compound is always prepared in a wet, and, consequently, harmless condition, it would appear that the desiccation of the mass is afterwards carried on in close proximity to the less dangerous departments of the works. It is truly lamentable that, after the prolonged researches of Schönbein, Abel, Brown, and others, the information and particulars brought to light should not have been more appreciated and made use of by those so directly interested in the matter; for one cannot help thinking that if the business of the Stowmarket Company had been carried on under competent scientific supervision, we should not now have to lament so deplorable an accident.

While then we must all deeply regret this sad occurrence it is to be hoped that the favourable judgment passed upon gun-cotton by scientific men during the last ten years will not be completely ignored; but that, on the contrary, a proper use may be made of the valuable information at our disposal by employing it in the framing of regulations to govern more strictly and efficiently the manufacture of explosives.

H. B. P.

PENDULUM AUTOGRAPHS

I.

PERHAPS I shall best put the reader in possession of all that I have to say, and shall best explain the nature of the accompanying figures, by giving some account of the successive steps that first led me to their discovery—a genuine discovery, so far as I was concerned, though I know there must be many to whom these curves and their mathematical properties are familiar, and who will smile at the tardy stages of experiment through which I had to pass, while they cannot refuse to congratulate me on my final success.

FIG. 1.—Proportion 1 : 3.—Cusped type.

FIG. 2.—Proportion 1 : 3.—Looped type.

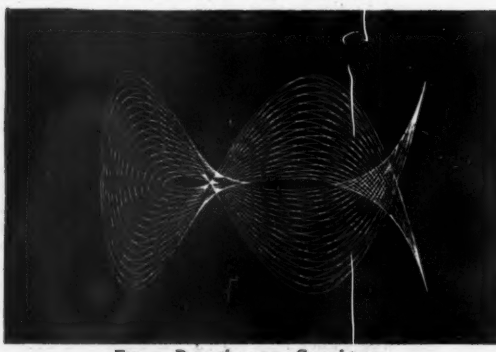

FIG. 3.—Proportion 2 : 5.—Cusped type.

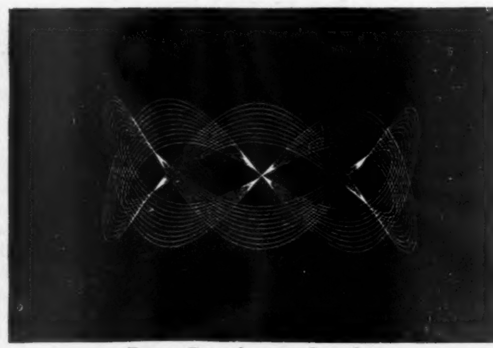

FIG. 4.—Proportion 2 : 5.—Looped type.

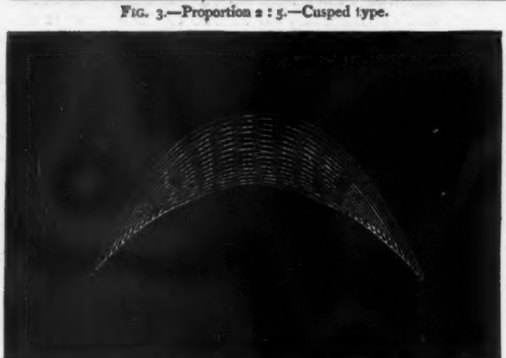

FIG. 5.—Proportion 1 : 2.—Cusped type.

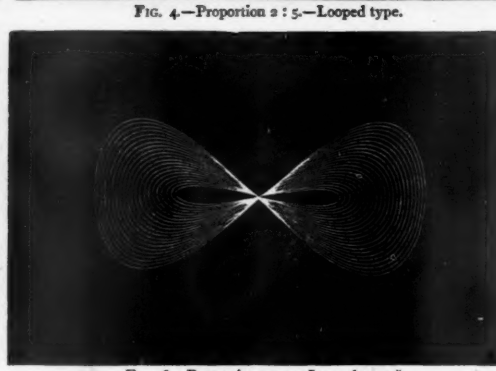

FIG. 6.—Proportion 1 : 2.—Looped type.*

It was a happy chance that directed my fingers, in an idle mood, one day in March of last year, to the top of a stiff twig that sprang from the stool of an old acacia, and rose to a height of about three feet, where it had been lopped by the gardener's knife. Pulling the twig aside, and letting it fly back by its own elasticity, I noticed the path which its top traced in the air; it was not difficult to follow its course, for the raw section of the wood was white and caught the eye, and the motion was not very rapid, the twig being rather slender for its height. I had often noticed—everyone must have noticed—odd behaviour in springs of various kinds before this, but the motion had been too quick or too slow to show the law that governed it. On the present occasion I could see that the twig began at once to deviate from the plane of its first vibration, and to describe an elliptic path, the ellipse growing wider and shorter till it was nearly circular, then still wider and still shorter, till its width exceeded its length, and it was again elliptic, but the long axis now occupied nearly the position of what was the short axis before. The new ellipse still grew narrower at every vibration, and

* Figs. 7—12 will be found in the second part of this article.

at last became a straight line in a second plane at right angles (roughly speaking) to the first. The vibration continuing, the twig began to retrace its path, and returned to the plane in which it started, by a complete recantation of its former errors, though the gradually failing strength of its oscillation was gradually diminishing the range of its orbit. No sooner was the original primary plane regained, than it was again forsaken for the secondary, the errant twig repeating its delirious maze of elliptic gyration, but always with a method in its madness, across and across, again and again, till it finally came to rest in the centre of its web, still striving to the very last perceptible tremor to persevere in its life-long career of consistent vacillation.

Repeating the experiment again and again, I found that there were two planes, at right angles, in either of which the twig would vibrate obediently, without deviation to one side or the other, and that the primary and secondary planes of the first experiment made equal angles with either plane of obedient vibration. When the twig was started only a few degrees on one side of either plane of obedience, its elliptic error carried it into a secondary plane only a few degrees on the other side, and then back again and again; while if the primary plane was chosen half-way between those planes of obedience, in opposite quadrants, then the secondary plane was found to lie half way in the alternate quadrants, at right angles to the primary.

How to explain this phenomenon was a puzzle, till my father hinted that its law might lie in a difference of periods of oscillation in those two planes of obedience, caused probably by the curved shape of the twig or perhaps by its elliptic section, at any rate caused by some condition which made the twig vibrate as a short spring with short period in one direction, and as a long spring with long period in another direction at right angles to the first.

This hint gave the key to the puzzle, and it was easy to demonstrate that all the phenomena would necessarily follow on such an assumption. Laying down two systems of rectangular co-ordinates to represent the spaces described in so many units of time (the motion of the twig being resolved in those two directions at right angles), and making n such spaces in one direction and $n + 1$ in the other, we had a diagram on which we could trace the twig's path, beginning at one corner and drawing the diagonals in the successive rectangular spaces. If there were n such spaces in both directions (which would represent equal periods of oscillation), our course of diagonals would only carry us into the opposite corner, with no alternative but to retrace the same line to and fro without deviation; but since in one direction there remains one space over when we reach the border of our diagram, our course of diagonals carries us across the corner, and our path returns with the width of one space between it and its former self; in like manner, on reaching the border of the diagram near the starting-corner, the course of the diagonals carries us across to the other side of our first track, and we make a second journey only to wander still farther from our first path in the return. The error increases at every turn, till at last the path of our imaginary twig finds itself wholly forgetful of the corners with which its shuttle-play began, and giving all its allegiance to the alternate pair. At last our diagonals are all described, and we find that they end in one corner or the other according as n is even or odd, and the twig must then be supposed to retrace its maze. If we make our spaces all equal, the track of our twig looks very angular, like the path of a cracker; but if we endeavour to imitate the truth by greatly diminishing the marginal spaces, our diagonal track becomes bent into a series of quasi-elliptic curves, which represent with tolerable accuracy the path of our twig, if we suppose it to vibrate without frictional retardation (see Fig. 13).

We shall get the due diminution of the marginal spaces by drawing our two sets of parallel lines through two sets of points in the circumference of a circle, equidistant for each set, but allowing only n equal spaces in the semicircumference for the n period, and $n + 1$ for the other.

Introducing friction, we have a gradual diminution of the orbit, which brings our twig finally to rest in the centre of the diagram. But this friction has greater effect in the direction of shorter period, because our twig has to make $n + 1$ journeys in that direction to n in the other, consequently the range of the orbit in the former direction will undergo more rapid contraction than in the latter, and the twig will sooner come to rest in the one plane than in the other; so that if there is large disproportion between n and $n + 1$, there will remain a residue of surplus vibration in the direction corresponding to the long period after all motion in the cross-plane has been arrested. This is easily seen by experiment on a twig that vibrates much more rapidly in one direction than in the other.

Having a desire to get a permanent record of the fleeting footsteps of my acacia-twig, I forced the butt-end of a small dance-pencil into the soft pith in the centre of the top-section, and set the twig vibrating with one hand, while with the other I held a sheet of note-paper in contact with the pencil-point. As might be supposed, the result was not satisfactory, but very suggestive. The twig was not strong enough to overcome the resistance of friction between pencil and paper, and the hand-suspension for the latter was very inefficient. I soon found an upright hazel-stem nearly an inch in diameter, possessing all the vibratile properties of my slender acacia-twig with much

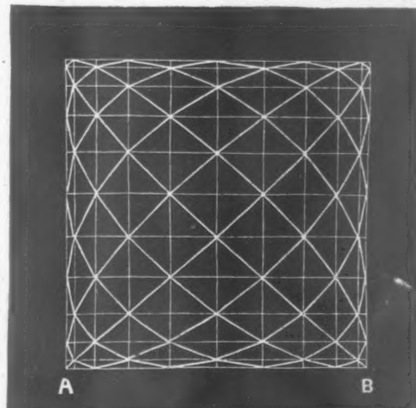

FIG. 13.—Diagram showing approximately the theoretical path of a spring vibrating without friction, with periods of vibration in cross-planes in the proportion of n to $n + 1$. ($n = 10$.) A and B are the beginning and end of the cycle, perpetually retraced, and are analogous to the two cusps of Fig. 9 or Fig. 11.

greater strength, and transferred my pencil to its new abode. For suspension of paper I erected a wigwam of four poles round the hazel, and stretched a quarto leaf by india-rubber bands from the four poles to the four corners close above the pencil. Then pulling the hazel aside, I adjusted the paper-suspension till I was sure of good contact with the pencil, and then let go:—buzz—a momentary rustle under the paper, and the thing was done; and, on loosing the elastic bands, I found the path of my pencil-point faithfully traced in delicate lines, which the eye could follow from the starting-point till lost in the mazy confusion of the centre where the manifold crossings and recrossings were inextricably entangled. By starting the hazel again and again, leaving the paper undisturbed,

I procured three or four path-tracks superposed, including vibrations in the planes of obedience, by which it was easy and instructive to examine at leisure the geometrical relations of the various planes. Fig. 14 is a specimen of these twig-tracings with cross-vibrations to show the

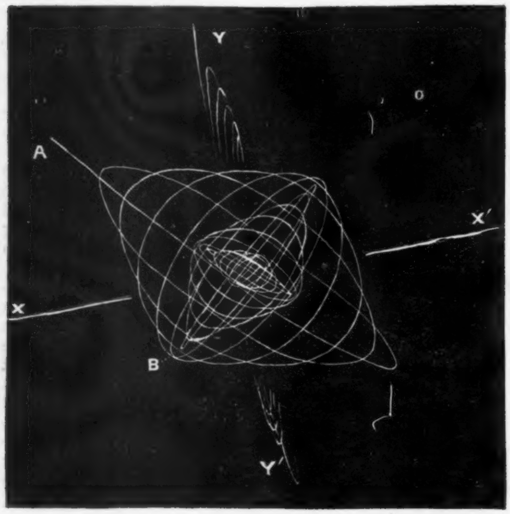

FIG. 14.—Specimen (obtained from nature) of the path of a stiff vibrating hazel shoot. Much friction. A, the starting-point. B, the end of the first cycle X X′, the path of the twig set vibrating exactly in the plane of slow vibration. Y Y′, nearly in the plane of quick vibration.

planes of obedience (XX′, YY′.) A is the starting point, and B the point where the first retrograde step begins in the secondary plane. It will be seen on examination that from A to B the twig has accomplished exactly six quasi-elliptic journeys resolved parallel to the plane XX′, and six and a half resolved parallel to YY′. So XX′ is the plane of slow vibration, and YY′ is the plane of quick vibration, and the periods of vibration in those two planes respectively are in the proportion of 13 to 12.

While considering these points, it occurred to me that similar results would be given by the oscillation of a pendulum jointed in such a manner as to swing in one plane only by one joint, and in the cross-plane only by a second joint at a different level from the first. The oscillation from the lower joint would be more rapid than that from the higher, and we should have exactly the same conditions of simultaneous motion in two planes with unequal periods as we had in the case of the acacia-twig. This was easily tried. From a cross-bar on an extempore tripod-stand I hung a rod by string-hinges, with an intermediate piece having its joint-edges at right angles, so that the rod was swinging in one plane by the joint between the cross-bar and the intermediary, and in the cross-plane by the joint between the intermediary and the rod. In any intermediate plane the rod could only swing by *both* these joints; its motion being really and veritably resolved in those two planes at right angles; with a longer period for the part resolved in the plane allowed by the upper joint than for the part resolved in the plane allowed by the lower. With the help of a weight of lead at the bottom of the rod, my make-shift pendulum gave a capital illustration of the problem, and the gravity and deliberation of its behaviour afforded better opportunity for study than was given by the more brilliant but less persistent energy of the acacia-twig.

The next step that naturally suggested itself was to obtain a permanent authentic record of the grave gyrations of my pendulum. I wanted something more permanent than pencil-marks, and more delicate than the daubs produced by a paint-brush full of colour. Clearly I wanted a pen that would deliver its ink in any direction all round universally. Such a pen I obtained by taking a small piece of glass tube four or five inches long and about a quarter of an inch in diameter, and melting one end in the flame of a Bunsen's burner, and drawing it out to a capillary tube, then breaking the point off square, and smoothing the broken edges of the pore in the flame, to run smoothly on the paper. By suction I drew up a small quantity of ink into the tube through the microscopic pore at the point, and then fastened my pen in a groove at the end of the pendulum-rod by elastic bands, so that it could be raised or lowered within short limits at pleasure. Then having adjusted the elastic suspension of the paper so that it hung evenly beneath the pen with a slight concavity to accommodate the nearly spherical "locus" of the pen-point, I drew the pendulum aside, and lowered the pen till it was on the point of touching the paper, then let the pendulum recede till the pen actually touched the paper, and then let go. It was beautiful to see the unerring certainty with which the pen-point struck its curves in obedience to the law imposed by its two-fold suspension. The very first back-stroke began the deviation from the primary plane, and every successive stroke made the ellipse wider and shorter by steps whose regularity was marvellous to watch. Slowly and surely the figure was filled up, line within line, line across line, as the ever-changing ellipse oscillated slowly from one side to the other of the plane of slow vibration.

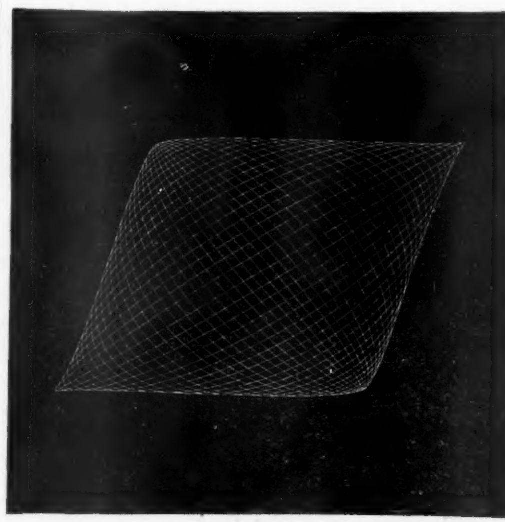

FIG. 15.—Curve traced by double-jointed pendulum, with proportion near unity, about 50 : 51.

Fig. 15 illustrates this stage of experiment. Contact in this case was purposely broken at the moment when the oscillation had reached the secondary plane. The tubular glass pen did its work very well, delivering the ink with ease and regularity, and gliding almost noiselessly over the paper with very little friction. But even that small amount of friction, added to hinge-rub and air-resistance, required great weight in the pendulum to overcome it. I kept adding one lump after another till there were forty or fifty pounds of lead lashed to the rod immediately above the pen. The elastic suspension of the paper, by india-rubber bands attached to the four corners, was very serviceable, and

with a little care it was not difficult to adjust the level of the paper, so that very little displacement was called for to meet the requirements of the pen's descent towards the centre of the figure, and that little was granted at once by the facility with which the india-rubber yielded to the demand. When the suspension was ill-adjusted, so that the pen-point pressed too heavily on the paper, there was a slight lateral displacement; but this danger was reduced almost to *nil* by using at each corner two elastic bands at right angles, instead of only one, ensuring resistance to any rotatory jerk in either direction.

A little more practice in the manufacture of the glass pen enabled me to improve the delicacy and uniformity of the lines. The chief difficulty lay in breaking the capillary tube square to the axis. The tube delighted in oblique fracture, which gave an oblique pore when the edges were smoothed in the flame, and the oblique pore was apt to write unequally in different directions, often refusing to write at all on one side of the figure, when the pore was not facing its work. Only now and then was the first fracture fortunately square; generally I had to pick at it with the finger-nail to reduce its obliquity. Latterly, I tried to ensure success by coating the point with a thin layer of bees' wax, tracing a fine groove in the wax round the slender tube, and allowing a drop of solution of fluoric acid to adhere round the groove until the acid had eaten into the glass and made it ready to break at the ring of corrosion. Then the remainder of the wax was washed off with turpentine, and the point was ready for its "baptism of fire." In this way I succeeded well with one or two pens, but the process was rather troublesome. That "baptism of fire" was another dangerous crisis in the early life of the pen, for the risk was great that it might be exposed to the flame just a fraction of a second too long, sealing the liquid lips for ever. A good way of testing the size of the pore—it was much too small to be examined by the naked eye—was to blow through it and notice the size of the current of air disturbing the pale blue flame of the Bunsen's burner. Alternately dipping the point for the tenth of a second in the outskirts of the furnace, and quickly withdrawing it, and trying its calibre by the breath, it was seen that the air-current grew smaller and smaller after every dip in the flame, till I dared not dip again, and then I had recourse to a powerful pocket-lens to examine the size of the pore and the smoothness of its lip. The diameter of pore of the best pen I have succeeded in making is 1-500th of an inch.

I grew discontented with common black ink for my pendulum-curves; it was apt to coagulate and choke the pore, frequently requiring the solvent power of sulphuric acid to restore free passage. Besides, I wished to have several figures superposed on the same paper, yet so that each should remain distinct. So I procured a set of coloured inks at the stationer's, price 1*d*. per bottle, and with these I was able to give additional interest to the sheets that were rapidly accumulating from all these trials of new ink, new pens, and new pendulums. For I soon grew discontented also with my first pendulum; its tripod was not strong enough, and its cord-hinges were very weak, and were fast fraying under the strain of 50 lbs. of lead in habitual oscillation below, and I feared a snap and a crash. I kept it in my bedroom, and at midnight I heard it creak, and could not rest until I had insinuated a rush-bottomed chair between the legs of the tripod, immediately below the lead, to break the fall which I fully expected. However, nothing happened, and in the morning I changed the frayed string for a trustworthy cord, and slept securely next night. I also made a new tripod with the aid of three surveying-poles, and improved the attachment of the pen by making it slide in a hole bored in the end of the rod, with a lateral screw to fix it at any required height.

HUBERT AIRY

(*To be continued.*)

THE BRITISH ASSOCIATION MEETING AT EDINBURGH

EDINBURGH, *Friday morning*

THE work—and play—of the Edinburgh meeting of the British Association is now over; the visitors have all left, except such as have remained to do honour to the memory of the great Magician of the North; indeed, for the last two days the Southerners have divided their allegiance between the British Association and the Scott Centenary. Instead of Spontaneous Generation and the Germ Theory of Disease, the Solar Eclipse and the great Dredging Expedition, we have heard quite as much of Abbotsford and Dryburgh, Jock o' Hazeldean and the Laird of Dumbiedikes.

As announced in our letter of last week, the concluding meeting of the General Committee was held in the University on Wednesday at one o'clock, Sir William Thomson in the chair. Dr. Hirst read certain regulations which were proposed by the Committee on Recommendations to be adopted relative to the proceedings of the sections. They had reference to the organisation and constitution of the Sectional Committees, but were merely in regard to matters of detail. In an appended circular, authors of papers were reminded that, under an arrangement dating from 1871, the acceptance of memoirs, and the days on which they were to be read, were now as far as possible determined by organising committees for the several sections before the beginning of the meeting. It had therefore become necessary that an author should prepare an abstract of his memoir, of a length suitable for insertion in the published transactions of the Association, and that he should send it, together with the original memoir, to the general secretaries in London a certain time before the meeting. If it should be inconvenient to the author that his paper should be read on any particular day, he was requested to send information thereof to the secretaries in a separate note. These resolutions, after some discussion, were adopted. The next subject referred to the General Committee on Recommendations had reference to Dr. King's proposal that there should be a subsection of Anthropology. Before the consideration of that suggestion was concluded, another came from Section D of a more definite nature; and, on considering both propositions together, the Committee on Recommendations decided that they could not recommend the adoption of Dr. King's motion, but that they could strongly recommend the adoption of the other. They therefore recommended—"That in future the division of the Section of Biology into the three departments of Anatomy and Physiology, Anthropology, and Zoology and Botany should be recognised in the programme of the Association meetings; and that the president, two vice-presidents, and at least three secretaries shall be appointed; and that the vice-presidents and secretaries, who shall take charge of the organisation of the several departments, should be designated respectively before the publication of each programme." That would virtually amount to the direct recognition of the three departments of Section D. Logically, it would be impossible to take any of these departments from Biology to make a separate section of it; but they were recognised distinctly, and the gentlemen who would preside over these departments would be stated by name. The recommendation was agreed to.

The following recommendations were then read and unanimously adopted:—

"That the President and Council of the British Association be authorised to co-operate with the President and Council of the Royal Society, in whatever manner may seem to them to be best, for the promotion of the circumnavigation expedition specially fitted out for carrying the physical and biological Exploration of the Deep-sea into all the great oceanic centres.

"That the President and general officers, with power to

add to their number be requested to take such steps as may seem to them desirable in order to promote observations on the forthcoming Solar Eclipse.

"That the Council be requested to take into consideration the desirability of the publication of the periodic records of the advances made in the various branches of science represented by the British Association.

"That it is desirable that the British Association apply to the Treasury for funds to enable the Tidal Committee to continue their calculations; and that it is desirable that the British Association should urge upon the Government of India the importance for navigation and other practical purposes, and for science, of making accurate and continued observations on the tides at several points on the coast of India.

"That the Council of the Association be requested to take such steps as to them may seem most expedient in relation to the proposal of Dr. Buys Ballot to establish a telegraphic meteorological station at the Azores.

"That the Council be requested to take such steps as they deem wisest in order to promote the introduction of scientific instruction into the elementary schools throughout the kingdom; and, secondly, that the Council of the Association be requested to take such steps as may appear to them desirable with reference to the arrangement now in contemplation to establish leaving examinations, and to report to the Association on the present position of science teaching in the public and first grade schools."

Dr. Thomson read the report on the resolutions involving applications for grants of money, which were as follow:—

KEW OBSERVATORY.	
The Council—Maintaining the establishment of Kew Observatory	£300
MATHEMATICS AND PHYSICS.	
Cayley, Professor—Mathematical Tables	50
Crossley, Mr.—Discussion of Observations of Lunar Objects	20
Tait, Prof.—Thermal Conductivity of Metals	25
Thomson, Prof. Sir W.—Tidal Observations	200
Brooke, Mr.—British Rainfall	100
Thomson, Prof. Sir W.—Underground Temperature	100
Glaisher, Mr.—Luminous Meteors	20
Huggins, Dr.—Tables of Inverse Wave Lengths	20
CHEMISTRY.	
Williamson, Prof.—Reports of the Progress of Chemistry	100
Williamson, Prof.—Testing Siemens' new Pyrometer	30
Gladstone, Dr.—Chemical Constitution and Optical Properties of Essential Oils	40
Brown, Dr. Crum—Thermal Equivalent of the Oxides of Chlorine	15
GEOLOGY	
Duncan, Dr.—Fossil Crustacea	25
Lyell, Sir C., Bart—Kent's Cavern Exploration	100
Harkness, Prof.—Investigation of Fossil Corals	25
Busk, Mr.—Fossil Elephants of Malta (renewed)	25
Harkness, Prof.—Collection of Fossils in the North-west of Scotland	10
Ramsay, Prof.—Mapping Positions of Erratic Blocks and Boulders	10
BIOLOGY	
Stainton, Mr.—Record of the Progress of Zoology	100
Balfour, Prof.—Effect of the Denudation of Timber on the Rainfall in North Britain (renewed)	20
Sharpey, Dr.—Physiological Action of Organic Compounds	25
Foster, Prof. M.—Terato-Embryological Inquiries	20
Foster, Prof. M.—Heat Generated in the Arterialisation of the Blood (part renewed)	15
Christison, Prof.—Antagonism of Poisonous Substances	20
GEOGRAPHY	
Murchison, Sir R.—Exploration of the Country of Moab	100
ECONOMIC SCIENCE AND STATISTICS	
Bowring, Sir J.—Metric Committee	75
MECHANICS	
Rankine, Prof.—Experiments on Fletcher's Rhysimeter	30
	£1,620

The whole of the proposed grants of money were approved of, the wording of the last being modified as follows: "Experiments to measure the speed of ships and currents by means of the difference in heights of two columns of liquid."

Dr. Thomson read a number of recommendations adopted by the Committee on Recommendations not involving grants of money, which were also approved of.

At the concluding meeting of the Association, held in the Music Hall at half-past two o'clock, Sir William Thomson in the chair, Dr. Thomson read the recommendations for grants of money and also the recommendations not involving money grants, which had been adopted by the General Committee. Mr. Griffiths stated that the number of tickets issued for this meeting had been as follows: Old life members, 246; new life members, 28; old annual members, 311; new annual members, 127; associates, 976; ladies (transferable tickets), 754; foreign members, 21—total, 2,463. The money received for these tickets was 2,575*l.*

It will be seen that the recommendations were almost more important than in any previous year. The last in particular, relative to the introduction of scientific instruction into the elementary schools of the country, covers a wider ground than is often included in the action of the Association. Wisely carried out, this recommendation may be pregnant of the most important results in the future; and serves to show that at least our leading scientific men are alive to the need there is for a strenuous effort to place the education of the country on a level with the requirements of the times. The scheme to which we referred in our leader last week, relative to the extension and improvement of the present system of giving scientific lectures to the people, was warmly taken up, and a committee appointed to carry it out. The application to the Government asking for 2,000*l.* in aid of the observation of the Total Eclipse in December next was sent off the same day.

Among the more important papers read during the present week were two on Tuesday in Section A, which it was agreed should be taken together: *On Government Action on Scientific Questions*, by Col. A. Strange, F.R.S.; and *On Obstacles to Teaching Science in Schools*, by the Rev. W. Tuckwell. In both these papers, of which we shall give full reports, very important issues were raised. The discussion on them was a highly interesting one, and was led by Prof. Tait, who said there existed an absolute necessity for a State system of instruction in Science; and was carried on by the Rev. T. G. Bonney, Mr. G. J. Stoney, Mr. James M. Wilson of Rugby, Mr. Pengelly, Mr. Boyd Dawkins, and others. An entire unanimity was displayed as to the pressing importance of both the subjects introduced. On Wednesday, Section D was enlivened by another Spontaneous Generation controversy, introduced by Dr. H. C. Bastian, who was supported by Dr. Burdon Sanderson, to the extent that we have at present no evidence that fungus or other germs are contained in the air in a vital condition. In closing the discussion, the President of the Section said that the subject was still one which must be considered as undecided. The proposal to enter into the discussion of Mr. Crookes's "Psychic Force," and the whole phenomena of so-called "Spiritualism," was rejected for want of time.

The excursions, which were arranged for yesterday, were uniformly well carried out and successful. About eighty ladies and gentlemen paid a visit to Hopetoun House and Dalmeny Castle. Forty ladies and gentlemen availed themselves of the trip to Rosslyn and Penicuik, and over 300 visited Melrose, Dryburgh, and Abbotsford.

The excursion of the Geologists was to Siccar Point and Fast Castle, under the leadership of Prof. Geikie. The object of the excursion was to visit the coast-line of Berwickshire, and examine the natural sections there, which have become classic in geology through the writings of

Hutton, Playfair, and Hall. The chief features of geological interest examined were:—First, the manner in which, at Siccar Point, the vertical and highly-inclined Lower Silurian strata are covered unconformably by the gently-inclined Upper Old Red sandstone. It was this section which furnished Hutton with one of the most telling arguments for his "Theory of the Earth," and his search and discovery of which have been so graphically described by Playfair. The sections presented indeed a magnificent example of uncomformable stratification; the Old Red strata lying almost horizontally on the vertical Silurians, a phenomenon expressed by the local papers by the phrase, not devoid of a certain dry humour, that "the Old Red rested uncomfortably on the Silurian!" We are bound however to state that on the whole the Edinburgh press was well up to the occasion; the Reports of the Addresses, Lectures, and Sectional Proceedings were good and full, and no pains were spared to make them really first-rate. The reports in the *Scotsman* should be mentioned in particular as unusually excellent.

The second point examined was the plication of the Lower Silurian rocks. Along this wild coast-line the greywacke and shale are thrown into many anticlinal and synclinal curves, extending from top to bottom of the cliffs, which are here in some places more than 500 feet high. Along the part of the coast to be examined by the excursionists the best folds occur at Fast Castle. It was the curving of these rocks which attracted the attention of Sir James Hall, and led him to investigate the subject in his well-known paper on "The Vertical Position and Convolutions of certain Strata," some of the illustrations from which may now be found copied into almost every text-book of geology.

A party of naturalists, numbering about sixty, joined in the Dredging Expedition off the Bass Rock. Amongst the gentlemen present were:—Prof. Wyville Thomson, Admiral Sir Edward Belcher, Sir Walter Elliott, Prof. Crum Brown, Prof. Margo, of Pesth; Prof. Purser, of Belfast; Dr Colding, of Copenhagen; Dr. Lüken; Dr. Copeland, of Parsonstown, Ireland; Dr. Lindeman, of Bremen; Mr. Shapter, Mr G Barclay, Mr. Ray Lankester, Mr. Shepherd, and Mr. Davis. There were also a number of ladies in the party.

About a hundred members and associates of the Association took part in a botanical excursion to the top of Ben Ledi, under the leadership of the veteran Prof. Balfour

The Conversazione held on Tuesday evening was a very good one; over 1,400 ladies and gentlemen attended. In addition to the varied contents of the Museum of Science and Art where the Conversazione was held, and which are themselves of no ordinary interest, the following were the most interesting objects exhibited:—Mr. Fowler's flint implements of the drift. Spencer's local heliostat, Dr. Gladstone's experiments in the crystallisation of metals by electricity under the microscope; flint implements from Palestine.

It only remains to be added, that, thanks to the admirable arrangements of the energetic local secretaries, Dr. Crum Brown and Mr. Rollo, everything went off well during the meeting; and the third Edinburgh meeting of the British Association will be looked back upon as one of the most enjoyable of a long series, as it certainly has been the most important for many years.

SECTION A.

THE greater part of the first day's session in this Section was occupied by a paper *On the Thermodynamics of the General Oceanic Circulation*, by Dr. W. B. Carpenter, and the interesting discussion which followed.

The inquiries in which the author, with his colleague, Prof. Wyville Thomson, has recently been engaged, into the physical condition of the deep sea, have furnished a new set of facts in regard to its thermal condition, which seem to point to conclusions very different from the doctrines usually received in regard to the movements of oceanic waters and their influence on climate. It may now be asserted as probable that the temperature of the bed of the ocean below 2,000 fathoms is everywhere, even under the equator, but little above 32° F., while it may be as low as 29·5° F. in particular channels of less depth, such as that which lies between the Shetland and the Faroe Islands. That this depression of temperature has no dependence on depth *per se*, appears to be conclusively proved by the fact that it does not show itself in the Mediterranean, for though depths of 1,600 fathoms have been sounded in its western basin, and 2,000 in its eastern basin, the temperature below the surface stratum of about fifty fathoms, heated by direct solar radiation, remains at a uniform level of about 54° to the very bottom, being in fact the average winter temperature of this vast mass of water, which may be regarded, as to all but its surface, in the light of an inland lake.

Now, if the condition of the Mediterranean be compared with that of the eastern border of the Atlantic under the same parallels, we find a most striking contrast in their thermal conditions. The superheating of the surface-stratum by direct solar radiation shows itself in the latter as in the former; below the surface-stratum there is a very gradual descent of the thermometer from about 53° to 49°, which last is the temperature at 800 fathoms; in the 200 fathoms below this there is a rapid loss of 9°, bringing the thermometer down to 40° at 1,000 fathoms; whilst beneath that line there is a further gradual descent with increase of depth, 36°·5 being the lowest temperature yet observed in this region. The author regarded this anomaly as due to the fact that the former was virtually cut off from the great oceanic circulation that diffuses over the latter the waters that have been chilled in the polar seas. The author found that the *primum mobile* of this circulation was not in equatorial heat (which being applied to the surface could exert no motor force beneath the thin stratum which it directly affects), but in polar cold, which by its action on the surface-water would produce the same kind of movement from above downwards, as heat applied at the bottom does from below upwards.

Supposing the whole surface of a limited basin of sea-water to be exposed to intense cold, the surface film, when rendered heavier by reduction of temperature, will sink, to be replaced from the warmer stratum beneath. The new surface-stratum will then be cooled; and the same process would be repeated until the temperature of the whole basin comes to be reduced as low as the cooling action will carry it—it may be down to 27° or even 25°. But suppose that only a portion of the surface area of the basin be exposed to cold, the phenomena would be different. (1) As each surface-film cools and sinks, its place will be supplied, not from below, but by a surface influx of the water around; and (2) the bottom stratum will flow away over the deepest parts of the basin, while, since the total heat of the liquid is kept up, there will be an upper stratum which will be drawn towards the cold area, to be precipitated to the bottom and repeat the action. Applying this principle to the great oceanic area that stretches between the Equator and the Poles, we should expect to find the upper stratum moving from the Equator towards the Poles, and its lower stratum from the Poles towards the Equator. That such a movement really takes place is indicated, as it seems to me, by various facts.

(1.) The general prevalence of a temperature not far above 32° over the deepest parts of the great ocean basin, which could scarcely be maintained if there were not a continual flow of cold water from the polar area.

(2.) The distinction between the upper and lower strata of Atlantic waters is shown by the change of temperature between 800 and 1000 fathoms.

(3.) The existence of a movement of warm surface-water towards both polar areas. From a consideration of these facts in detail, the author was led to the hypothesis of a north-easterly movement of a vast stratum of oceanic water, having a depth of at least 600 fathoms. In the remaining portion of his paper Dr. Carpenter discussed the different causes of horizontal and vertical currents. He was inclined to believe that the propulsive force of the trade winds produced only a horizontal motion.

Sir W. Thomson said that Dr. Carpenter's explanation had been so lucid and demonstrative that he thought little remained to be said. It seemed to him that Dr. Carpenter thoroughly established his case. The distinction drawn by him between horizontal and vertical circulation was important. When the path of least resistance was in a wide circuit along the surface, hen the chief return would be along the surface. In an

open ocean where there was a prevalence of winds in a certain direction over one part of it, it seemed necessary that the currents produced by that wind should be as Dr. Carpenter had maintained. The only case in which he could conceive of a return along the bottom produced by wind was one of great interest, but in which the circumstances were precisely opposite to those of an open oceanic circulation, viz. in the case of a frith or fiord. The elevations of 6, 8, or 10 feet, which we know result from high wind, must be thus explained; the return circulation cannot but be along the bottom. In the case of a frith, if the whole surface is carried up in a current, the water must get away somewhere. If there were a strong breeze in narrow waters when the whole surface was broken up, there would be a great deal of surface drift; but even without breaking up a surface there was a current necessarily accompanying waves at sea when the height of the wave was not infinitesimal, *i.e.*, when it was not very small in comparison with the length; sometimes there was a great surface current amounting to three or four knots in these circumstances, and there must be an equal outflow at the bottom. Dr. Carpenter's explanation of the vertical circulation seemed to make the whole thing perfectly clear. Ocean currents were altogether unknown, with the exception of a few isolated cases, and even regarding these the knowledge was not nearly practical enough for the ordinary purposes of navigation. In the operations of 1866 to recover the cable of 1865, it was discovered that the success or non-success altogether depended on the management of the ocean current. Captain Moriarty, who was chiefly concerned in finding the ship's place, came to the conclusion that the whole subject of ocean currents ought to be made a matter of hydrography, and certainly it was an object of all others appropriate to a nautical country. The question of temperature was also of great practical importance, as the temperature of the sea bottom along which the cable was to be laid was of enormous importance to the enterprise. If a cable showed certain signs at 49° F. it was good, if it showed the same signs at 40° F. it was bad. Another most serious practical want was to know precisely the temperature of the cable when laid, in order that if there was a fault its temperature might be accurately determined.

Prof. Stokes said that if he had risen first, he would have pointed out what had been so well stated by Sir W. Thomson, that the only case in which a vertical circulation could be produced in the horizontal blow forward by wind, was in the case of a narrow channel. If a portion of a widely-extended ocean were blown on by the wind, the water would be propelled forward, but the tendency would be to take it in from all directions, not merely from one, so that the inflow would be lost in minuteness. That a surface-current is a necessary accompaniment of waves, seemed pretty obvious. If waves are already in existence on the surface of water, it is evident that their backs must be more strongly acted on than their fronts by the wind; there must be a horizontal resultant forward which must push on the water somehow or other; the fact of the existence of these waves implied that there was already a surface current of a certain amount.

Mr. Robert Russell said he could only go a certain distance with Dr. Carpenter; he considered the effect of polar cold and equatorial heat to be comparatively small compared with the wind. The Atlantic itself narrows so much towards the North Pole, that its vast surface is forced by the south-west wind to the northern ocean, and is forced into it in spite of polar cold.

Prof. G. C. Foster said that a possible cause of the formation of currents was the coexistence of different specific gravities in neighbouring quantities of water.

Dr. Carpenter said it gave him great satisfaction to hear the general agreement of Sir W. Thomson with the views that he had advanced; he had expressly spoken of the open ocean, and mentioned as excepted such cases as the Gibraltar current. With regard to cables, Capt. Sherard Osborne had mentioned to him that the cable recently laid down in the Eastern seas towards China was generally in shallow water and therefore warm, so as to diminish the conducting power of the wire, but at one point it dipped down into a hole, and there the temperature having fallen the conducting power was greatly improved. Everyone knew that when the cable was cut and buoyed in 1865, there was a long wire rope with a buoy attached to it. It got adrift, and was seen by an Atlantic mail steamer 10° to the southward. One would have expected it to the North-East, through the influence of the Gulf Stream. It was suggested that the long rope had broken away at the bottom; that its long tail was hanging in the sea, and the action of the great lower movement to the south might have been stronger on the tail than the action of the surface water on the upper portion of the rope.

Mr. Buchan said that the Scottish Meteorological Society were conducting investigations which would settle what were the winds and currents over each degree of a portion of the Atlantic.

Mr. Scott said he hoped to give Mr. Buchan charts of the currents over the area such as were never before possessed. They were derived from all available sources of information.

Sir W. Thomson said it seemed demonstrable that in all water above five or ten fathoms deep, the current under return due to surface drift was insensibly small, and he thought that this demonstrated Dr. Carpenter's statement, that the main current could not be produced by wind, though the wind might produce very considerable surface currents.

Prof. Colding, who stated he had been working at the same subject for many years since, made some remarks on the effect of the earth's rotation on the currents, and

Prof. Tait remarked that the discussion well illustrated the use of the British Association.

Observations Physiques en Ballon, by M. Janssen.

SECTION B.

THIS section did not sit on Saturday, and on Monday the proceedings commenced with two short papers by the President, Dr. Andrews, *On the Dichroism of the Vapour of Iodine and on the Action of Heat on Bromine.* The fine purple colour of the vapour of iodine arises from its transmitting freely the red and blue rays of the spectrum, while it absorbs nearly the whole of the green rays. The transmitted light passes freely through a red copper or a blue cobalt glass. But if the iodine vapour be sufficiently dense, the whole of the red rays are absorbed, and the transmitted rays are of a pure blue colour. They are now freely transmitted as before by the cobalt glass, but will not pass through the red glass. The solution of iodine in bisulphide of carbon exhibits a similar dichroism, and according to its density appears either purple or blue when white light is transmitted through it. The alcoholic solution, on the contrary, is of a red colour, and does not exhibit any dichroism. If a fine tube be filled one half with liquid bromine and one half with vapour of bromine, and after being hermetically sealed, is gradually heated until the temperature is above the critical point, the whole of the bromine becomes quite opaque, and the tube has the aspect of being filled with a dark red and opaque resin. A measure of the change of power of transmitting light in this case may be obtained by varying the proportion of liquid and vapour in the tube. Even liquid bromine transmits much less light when heated strongly in a hermetically sealed tube than in its ordinary state. In connection with this subject, Mr. Dewar exhibited an experiment illustrating the action of light upon peroxide of chlorine.

The report on the Utilisation of Sewage was presented by Mr. Grantham. It was divided under the following heads:—(1) Experiments on Britton's Farm, Mr. Hope. (2) Comparison of results during winter of Croydon, Norwood, and Britton's Farm experiments, Dr. Corfield. (3) Report on Analysis in connection with above, Dr. Corfield. (4) Upward Filtration of Sewage at Ely, Dr. Corfield. (5) Phosphate Process, Dr. Corfield. (6) Dry-Earth System at Lancaster, Drs. Corfield and Gilbert. Dr. Bischof read a paper *On the Examination of Water for Sanitary Purposes*, in which he sought to show that the appearance of the residue obtained by evaporation when seen under the microscope afforded a ready method of detecting sewage contamination.

Dr. Otto Richter contributed a paper *On the Chemical Constitution of Glycollic Alcohol and its Heterologues as viewed in the light of the Typo-nucleus Theory.* The Abbé Moigno gave an account of the history and working of the photographic post, and exhibited a number of collodion films containing microscopic photographs of letters and despatches. Every film reproduced twelve or sixteen folio pages of printing, and contained on an average 3,000 despatches. The whole of the official and private despatches came by pigeons during the investment of Paris, numbered about 115,000, weighing in all about two grammes.

Dr. Wright gave an account of some experiments *On the Essential Oil of Orange Peel.* It has been shown that this oil consists principally of a hydrocarbon, hesperidene, $C_{10}H_{16}$, and an amorphous resin of the formula $C_{20}H_{30}O_3$. When hesperidene is boiled "per ascensum" with sulphuric acid and potassium bichromate, carbon dioxide is slowly evolved, and acetic acid produced, whence it is inferred that the structure of the hydrocarbon is CH_3

$CH\,(C_8H_{12})$."

SECTION C.

After the reading of Prof. Geikie's Report on the Progress of the Geological Survey, Mr. James Thomson, F.G.S., read a paper *On the Age of the Stratified Rocks of Isla*. He gave an account of the general character and relations of the beds, which are much affected by intrusive igneous rocks, and illustrated the subject by two sections—one of the east coast of Isla and a transverse section of the same. His paper contained much detail, which was hardly of sufficient interest to a general audience, but it clearly showed an amount of careful investigation that will prove of great value to geologists.

In the discussion which followed, Mr. Geikie differed from the author in his identification of the Fundamental Gneiss, and he thought sufficient evidence of its presence had not been brought forward. Professor Harkness regarded the Gneiss as corresponding with the newer gneiss of the Highlands. Mr. Thomson, in reference to some remarks upon *Eozöon*, stated that having sent to Dr. Carpenter some specimens of the rock, he reported that *Eozöon* structure was not sufficiently distinct to warrant him in calling it *Eozöon*.

The *Third Report of the Committee on Earthquakes in Scotland* was communicated by Dr. Bryce, F.R.G.S., F.G.S. There was nothing, however, of importance to make known, but a few slight earthquakes having been felt—one at Lochaber and another in the upper part of the Firth of Clyde. In regard to the latter, very little information that could be depended upon had been obtained, but there was less doubt respecting the other. It occurred in a district in which some of our most severe earthquakes have taken place. However, in the absence of any recording instruments, it has been impossible to state with certainty the intensity of the shocks. The Committee recommend the adoption of a much simpler form of Seismometer than that at Comrie belonging to the Association; they also proposed placing such an instrument at a number of the meteorological stations which are within the area liable to disturbance.

Mr. Henry Woodward, F.G.S., read his *Report on the Structure and Classification of the Fossil Crustacea*, first noticing the new forms discovered and described during the past year, which amounted in all to 21 species, including 6 Decapods, 1 Amphipod, 2 Isopods, 1 Eurypterid, and 13 Phyllopods. He referred to the wide distribution of a new Cretaceous Isopod (*Palæga Carteri*) which had been found in Upper Silesia, at Turin, and in three localities in England, and pointed out that if the conclusions arrived at by Mr. Billings and himself as to the Trilobites possessing legs be established by further research, then that group would carry the Isopodous class back in time to our earliest Palæozoic rocks.

The structure of *Dictyoxylon* (*D. Grievii*), a new species of which had been discovered by Mr. G. J. Grieve, near Burntisland, formed the subject of some remarks by Prof. W. C. Williamson. He regarded the form as of a type belonging to the Coal Measures.

SECTION D.

SUB-SECTION.—ZOOLOGY AND BOTANY

The Committee for the Foundation of Zoological Sections in Different Parts of the Globe, reported that since the last meeting at Liverpool steps were taken by Dr. Dohrn to secure the moral assistance of some other scientific bodies, that the Academy of Belgium had passed a vote acknowledging the great value of the proposed Observatories. Besides, the Government at Berlin had given instruction to the German Embassy at Florence and to the General Consul at Naples for Germany to do everything to secure success to Dr. Dohrn's enterprise. Next October the building at Naples will commence, under Dr. Dohrn's personal superintendence, who will be accompanied by the assistant architect of the Berlin Aquarium. The contractor is to finish the building in one year, so that in January 1873 the Aquarium in Naples may be hoped to be in working order.

The Naples Observatory being thus arranged for, the Committee urged the importance of establishing a Zoological Station in the British Islands, and to the opportunity, which is now offered for such a proposition in consequence of the cessation of the grant to the Kew Observatory. In the same way as the Association took the initiative in the foundation of Meteorological Observatories, so may they legitimately, and with every prospect of success, take in hand the foundation of Zoological Observatories. Until a recent date the Association has given considerable sums of money to dredging explorations; but in consequence of the advance in Zoological Science the problems are so much changed, and their nature is of such a character as to demand the assistance of the Association in other directions. The careful study of the development and the habits of marine animals can only be carried on by aid of larger Aquariums and cumbrous apparatus, which an individual could hardly provide for himself. This and the copious supply of animals for observation can be provided by such a co-operative institution. There can be little doubt of the convenience to Naturalists and the benefit to science which would be brought about by the foundation of a Zoological Station in the British Isles.

The Committee recommends that a Committee of the Association be formed for the purpose of erecting a Zoological Station at a convenient place on the South Coast of England, say Torquay, and that a sufficient sum of money be placed at their disposal either by a single or a series of annual grants.

Prof. E. Perceval Wright suggested that Bantry Bay would be a good place for establishing such a station. Here scientific research could be carried on at a very trifling expense, and although no return would be obtained from visitors to the Aquarium, yet from this station other Aquaria might be supplied at a remunerative rate. Prof. Lawson remarked that such a station might be turned to good account for the investigation of the marine Flora as well as Fauna. Prof. Dunns trusted the Department would make a very hearty recommendation to the Council of the Association on this subject, in which Prof. Wyville Thomson concurred; and Dr. Sclater, who had read the Report, promised that the matter should be laid before the full Committee of the Section.

The Report was signed by Dr. A. Dohrn, Prof. Rolleston, and Dr. Sclater.

SUB-SECTION.—ANTHROPOLOGY

Prof. W. Turner opened the Section with an address from the chair, in which he traced the rise and growth of the science of Anthropology, and the vicissitudes in the fortunes of the sub-section over which he presided. Anthropology was first allowed place in the proceedings of the British Association under the head of Zoology and Botany; then it was assigned to the department of Geography, and at last, in 1865, resumed again its old place under the newly named department of Biology, which embraced not merely Zoology and Botany, but the whole science of organisation. The science of man obviously has an organic connection with Biology, and ranges itself naturally under that master science. Within its scope falls everything which has a direct bearing on man, and as nearly every branch of human knowledge has a relation, more or less, to man, questions may occasionally arise whether papers brought before the sub-section come within its province or more naturally belong to the other sections. The most satisfactory way of solving this difficulty would be for the different sections concerned to come to a common understanding, that all papers, which treat of the origin and progress of mankind, should be forwarded to the Department of Anthropology. The term Anthropologists—ἀνθρωπολογοι—was first used by Aristotle, as to denote "gossips," or talkers about men rather than facts. And if we lay claim to the title, let it not be in this sense, but in the nobler and wider sense of humble and patient students of the great science of human nature.

Dr. Beddoe then read a paper *On the Degeneration of Races in Britain*, in which he urged the necessity of systematic inquiry into the physical changes which are now taking place in our population. Of the four countries—England, Wales, Scotland, and Ireland—the first, which is the richest, and considered to be the most advanced in material civilisation, and whose habits and modes of life are more and more imitated by the others, is, according to Edward Smith's reports on the subject, the one in which the people are most scantily and ill-nourished. The scarcity of milk especially, as to its supply to children in towns and in dairy districts, is a growing evil, and one of national importance. Here may be mentioned, as having probably a relation to the quality of the food, and possibly to this very defect of milk, the apparently growing evil of unsound teeth, which, again, seems to advance *pari passu* with the advance of material civilisation, and is worst among the English and the townsmen of the United States, not so conspicuous among the Scotch, and decidedly at the minimum among the Irish. Certain changes in the process of natural selection, as it operates on our people, seem to be on the whole detrimental to the standard of physical type. Emigration drains away large numbers of the stronger and more energetic young men from the best of oue districts; so do the military and civil service in India; and thr voids are supplied to a less extent than they used to be from the

rural population, wherein the rates of marriage and of birth are much less than in that of the towns. The classes that yield the largest number of births are, beginning with the least important —(1), fishermen; (2), miners, especially coal-miners, and the like; (3), the proletariat of large towns. Whatever may be said of the two former, this last and most important is, physically, about the worst developed in the kingdom. Formerly it did not tend to increase in numbers, relatively, to other classes, because the death-rate in the worst quarters of towns was so high as to balance or overbalance the birth-rate—such was the case not long ago in Liverpool, for example. But the effect of sanitary improvements has been so considerable, that the rates of sickness and death in these quarters are being decidedly ameliorated; and this improvement, regarded dispassionately, is no more an unmixed good than are good things in general; for the increase in the number of survivors brings about a disproportionate augmentation in the numbers of the class in question, and thus lowers the average standard of physical development.

SECTION G.

MECHANICAL SCIENCE

OPENING ADDRESS BY THE PRESIDENT, PROF. FLEEMING JENKIN

IN addressing you on the subject of Mechanical Science in our ancient university, I propose to speak on the somewhat threadbare topic of technical instruction. The panic with which some persons regarded the rapid improvement made abroad in manufactures has subsided, but I hope that you will be all the more ready on that account to listen to a few suggestions as to steps which may be immediately taken to improve the education of those who apply science to practical ends. The subject does not owe its prominence to any events of to-day or of yesterday; it has long been, and will long be, of paramount importance to this country that the education of the producers of wealth should be such as will enable them, not merely to compete on advantageous terms with foreigners, but rather to master the great forces of nature by which we work. That we have gained some triumphs can be no reason for relaxing our efforts. With each advance further advance becomes more difficult, and requires more knowledge. The first rude implements and processes employed by man certainly required for their explanation or acquirement no book-learning; but as processes become complex, and implements develop into machines, as the occupations of men differ more and more, practice alone is found insufficient to give skill, and study becomes the necessary preparation for all successful work. Our first engineers were not learned men; strong good sense and long practice enabled them to overcome the comparatively simple questions with which they dealt. All honour to those great men; but we who have to deal with more complex, if not with vaster problems, cannot trust to good sense alone, even if we possess it, but must arm ourselves by the study of science and its application to the arts. This being granted, how shall it be done? I need not trouble you by refuting the absurdities of a few men, who would have those things taught at schools which have hitherto been taught by practice. What has been taught by practice must still be taught by practice. The business of the school is to teach those things which practice in an art will not teach a man. Let us apply this principle to engineering —the most scientific of all professions It will be most useless to lecture on filing and chipping; it will be useless to describe the mere forms and arrangements of vast multitudes of machines; one kind of knowledge of the properties of materials can only be acquired, as it always has been acquired, by actually handling them; and the knowledge of the arrangement of a machine is far better learnt by mere inspection than from fifty lectures; moreover, it can be acquired by an intelligent man, even if he be wholly unlettered. Book learning about estimates, the value of goods, methods of superintending work, and dealing with men, is foolishness. Written descriptions of puddling a clay embankment, excavating, and such operations, give no knowledge; and yet a vast mass of such knowledge must, at some time of his life, be acquired by the engineer, and the student cannot be employed as an engineer until he has laid up a store of such knowledge. Colleges cannot give him this; he must serve an apprenticeship in fact if not in form; young foreigners taught in colleges serve their apprenticeship, at the cost of their employers, during the first few years of their professional life. We call the tyro an apprentice or pupil, and he pays his master instead of being paid by him. I have the strongest feeling against any attempt to substitute collegiate teaching for practical apprenticeship; so far as colleges attempt to teach practice, they are and will be a sham in this country and in all others. The work of a college is to teach those sciences which are applied in the arts; but it can go a little further, and indicate to its students how the application is made in at least a few selected instances. Applying this dictum to the education of an engineer, his college can teach him mathematics, natural philosophy, chemistry, and geology. No one can doubt that a youth well trained in these branches of knowledge will, even with no further teaching, learn more during his apprenticeship, and during his whole professional life will take a higher standing, than the man of equal intelligence untrained in science. College can, however, do more than this; it is found that a lad will go through a considerable number of books of Euclid, and yet see so dimly how his knowledge is to be connected with practice that he may be unable even to compute the area of a field the dimensions of which are well known to him; and far more is it seen that a man may be fairly grounded in mathematics, and yet have very little idea how to apply his knowledge to mechanical problems. It is the business of those who hold such chairs as mine to point out the connection between pure science and practice; to show how mathematics are employed in mensuration and in mechanical calculations; to show how the truths of physics are made use of in designing economical machinery, as when we teach the connection between the laws of heat and the steam engine. The student who has once grasped the fact that there is a real connection between practice and theory will seldom be at a loss how to find or search for that connection in after life. The student thus prepared knows what he has to learn from practice, and need not lose precious time in blundering over the numberless scientific problems which practice is sure to suggest but can never solve. The education of the architect, the practical chemist, the manufacturer, and the merchant, must be similar, *mutatis mutandis*, with that of the engineer. Assuming, then, that the education of those who are to follow more or less scientific pursuits must consist in acquiring first, that theoretical knowledge which practice cannot give, and, secondly, the practical knowledge which schools should not attempt to give, there remains the question whether the theoretical preparation should be given in special colleges, or universities such as our own. I have no hesitation in preferring the university. Mathematics, physics, chemistry, geology, botany, languages, all form elements required in various combinations in the education of all students. There is but one kind of mathematics, one kind of pure physics, and so forth. Surely it is better that we should teach the men belonging to different professions side by side, so long as the matter taught is to be the same. There are many dangers in an opposite course. There are not a sufficient number of competent teachers to allow of much differentiation. Segregation at an early age is not apt to foster professional peculiarities and narrow-mindedness. There is great danger, if physics are to be taught specially to engineers, that a special kind of physics, erroneously supposed to be specially useful to them, will be invented. Lastly, the contact of students and professors of one faculty with the students and professors of other faculties is very beneficial to all. Do not, therefore, cripple old universities by withdrawing from them a portion of their students and their professors, to set up special, professional, or technical colleges of a novel kind, but rather add by degrees to the power and usefulness of old institutions, and found new colleges and universities after the model of those which are found to have done good work. As an example of what may be safely done, I consider that in Edinburgh we require a chair of architecture, and lectureships on navigation and on telegraphy. There is, further, much want of a teacher of mechanical drawing The professors of physics and chemistry require additional accommodation for practical laboratories, and additional assistance. If these additions were made, our college would, in my opinion, meet all the requirements for superior technical education in this part of Scotland. For 2,000*l.* per annum all these additions might be made. Notwithstanding the acknowledged importance of education, establishments for giving the higher kinds of instruction are never self-supporting, and students must everywhere be bribed to come and learn. Immediate prizes, in the form of bursaries, scholarships, and fellowships, are required to induce men to cultivate the older fields of learning, and similar bribes are needed to promote the tillage of the more recently colonised domains of applied science. The Whitworth scholarships are a noble example of munificence thus directed, although, in my opinion, the examination requires considerable reform. I hope that further benefits of this kind will be conferred on those colleges which give efficient teaching. Local ambition is

most effectually stirred by local prizes, and I regret to find a certain apathy among students here with respect to the Whitworth competition. This appears to arise partly from dissatisfaction with the mode of examination, and partly from the fact that the examiners are men not well known in Scotland. Leaving the question of technical training for the upper classes, and the still larger question of scientific teaching in second grade schools, the consideration of which would lead us too far a-field, I purpose to say a few words on the technical education of the skilled artisan. This we must treat on the same principles as have been applied to professional teaching. We must endeavour to prepare the lad in school, by teaching him those things which he cannot learn in workshops, but which will enable him to work with greater intelligence while acquiring and applying his practical knowledge. I shall not now speak of the general education which should make him a good man, and which should open to him those great sources of rational enjoyment arising from culture; I will restrict myself entirely to his preparation for becoming an efficient workman. I have in many places said, and I cannot say too often, that the great want of the workman is a knowledge of mechanical drawing. Unfortunately, I can obtain little attention from the general public to this demand for the workman. Very few persons not being engineers know at all what mechanical drawing is. I am sorry to say that some examiners in high places, who direct the education of the country, know very little more than the general public, and teachers who should give bread give chaff. I have lived much abroad, and come into close contact both with English and foreign workmen, and I unhesitatingly say that the chief, if not the only, inferiority of Englishmen has been in this one branch of knowledge. I must explain to some of my hearers what mechanical drawing is. It is the art of representing any object so accurately that a skilled workman, upon inspecting the drawing, shall be able to make the object of exactly the materials and dimensions shown, without any further verbal or written instructions from the designer. The objects represented may be machines, implements, buildings, utensils, or ornaments. They may be constructed of every material. The drawings may be linear, shaded and coloured, or plain. They must necessarily be drawn to scale, but various geometrical methods may be employed. The name of mechanical drawing is given to one and all those representations the object of which is to enable the thing drawn to be made by a workman. Artistic drawing aims at representing agreeably something already in existence, or which might exist, and for the sake of the representation; mechanical drawing aims at representing the object, not for the sake of the representation, but in order to facilitate the production of the thing represented. Now, I say that it is this latter kind of drawing which is so vastly important to our artisans, and hence to our whole wealth-producing population. Very few workmen, or men of any class, can hope to acquire such excellence in artistic drawing that their productions will give pleasure to themselves and others; but a great number of workmen must acquire some knowledge of the drawings of those things which they produce, and there is not one skilled workman or woman who would not be better qualified by a knowledge of mechanical drawing to do his work with ease to himself and benefit to the public. Mechanical drawing is a rudimentary acquirement, of the nature of reading, writing, and arithmetic. In order that a man may understand the illustrated description of a machine, he must understand this kind of drawing. To the general public an engineering drawing is as unintelligible as a printed book is to a man who cannot read. The general public can no more put their ideas into such a shape that workmen can carry them out, than a person ignorant of writing can convey their meaning on paper. Reading and writing on mechanical or industrial subjects is impossible without some knowledge of the art I am pressing on your attention. This art is taught abroad in every industrial school; a great part of the school-time is given up to it. In a Prussian industrial school one-third of the whole time is given to it. A French commission on technical education reported that drawing, with all its applications to the different industrial arts, should be considered as the principal means to be employed in technical education. Now, I deliberately state that this subject is not taught at all in England, and that the ignorance of it is so great that I can obtain no attention to my complaints. A hundred times more money is spent by Government to encourage artistic drawing than is given to encourage mechanical drawing, and I say that mechanical drawing is a hundred times more important to us as a nation. Moreover, the little *quasi*-mechanical drawing which is taught is mostly mere geometrical projection, a subject of which real draughtsmen very frequently, and with little loss to themselves, are profoundly ignorant. Descriptive geometry and geometrical projection are nearly useless branches of the art, and the little encouragement which is given is almost monopolised by these. Mechanical drawing proper is confined to those who pick it up by practice in engineering offices. These draughtsmen are often excellent, and on their behoof I claim no other teaching. I speak for the artisan who makes and for him who uses machinery. There are two ways in which our shortcomings may be remedied. First, the schools of art now established in this country should be enlarged so as to teach real mechanical drawing, and the examinations conducted by the Science and Art Department should be greatly modified; secondly, the drawing which is to be taught in the schools under the superintendence of the new school boards may be and ought to be mechanical drawing. Freehand drawing, as a branch of primary education, will, I fear, be a useless pastime; but whether that be so or not, I am certain that the accurate and neat representation of the elementary part of machinery and buildings would be popular with the pupils, and could be effectively taught. This kind of drawing educates hand and mind in accuracy, it teaches the students the elements of mensuration and geometry, and it affords considerable scope for taste where taste exists. The chief difficulty will be to obtain competent teachers. I should occupy you too long were I to attempt to show how these must themselves be trained. My chief aim to-day has been to claim attention for a most important and wholly neglected branch of education. I shall probably be expected to urge the teaching of other natural sciences in our primary schools; nothing, indeed, would give me greater pleasure than to think this could be done. I confess I doubt it, and while our second grade schools are what they are in this respect, and while the Cambridge examination for a degree in applied science is what it is, I dare not think of natural science classes in our primary schools. I shall be delighted if I am mistaken, but I am certain that mechanical drawing deserves our first attention, as most immediately useful to the artisan, and most easily taught. The very books on natural science which are published in England cannot be properly illustrated for want of competent draughtsmen, and children would be unable to follow the illustrations and diagrams, if ignorant of the principles on which they are constructed. I look rather to good reading books, explained by intelligent masters, as the best manner of teaching the elementary and all-important truths of natural science. No man could do better service than in compiling such reading-books, and there are few wants more urgent than that of masters competent to enlarge upon texts which would thus be put into their hands. The education of our workmen is far more incomplete than that of our professional men. Small additions to existing institutions will meet the want of the latter; but for the former the institutions have to be erected almost from the foundation.

SCIENTIFIC SERIALS

In the *Scottish Naturalist* for July, Dr. Lauder Lindsay finishes his article on Natural Science Chairs in our Universities, and concludes by pointing out that in this country the most eminent of our naturalists, Darwin, Owen, Huxley, Hooker, Bentham, Berkeley, Murchison, Lyell, Lubbock, Sclater, Wallace, Gwyn Jeffreys, are not, and never were, University professors, while many of the occupiers of natural history chairs have never properly discharged the duty of professors, and their opinions carry no authority in scientific matters. The remainder of the number is occupied by short articles and notes on various points of Scottish natural history.

The greater part of the *American Naturalist* for July is occupied by two long articles, entitled, "The Ancient Indian Pottery of Marajó, Brazil," by Prof. C. F. Hartt, and "Application of the Darwinian Theory to Flowers and the Insects which visit them," both illustrated with cuts. The latter is a re-translation of Prof. Delpino's annotated translation into Italian of Dr. Müller's address at Lippstadt in 1869. The former is a very interesting account of the pottery exhumed from the Indian burial places at various localities in the Valley of the Amazonas. These vases were used for the reception of the remains of the dead, and are found associated with rude idols. We have no historical record of the tribe that built the Marajó mounds, and no record of the existence of any tribe in the Lower Amazonas within historic times that buried its dead in jars. Prof. Hartt does not agree with von Martius in supposing these

mounds were made by Indians of Tupi descent. He thinks, on the other hand, that there are many resemblances between the pottery of Marajó and that of Peru and North America that are well worth study.

SOCIETIES AND ACADEMIES

Paris

Association Scientifique de France July 29.—M. Leverrier in the chair. The meeting took place in the hall of the Society for the Encouragement of National Industry, in the Rue Bonaparte, and was the first meeting since M. Leverrier was Director of the National Observatory. Subsequently to his dismissal an Imperial decree, dated July 13, 1870, had proclaimed the association to be an institution of public interest; but no meeting took place in consequence of the events of the war. The number of members amounts to ten thousand, subscribing eight shillings each, and the funds of the society are to be employed in promoting scientific experiments. The society is governed by a standing committee. M. Glais Bizoin, a member of the delegate government, M. Barral, the celebrated agriculturist, and many other scientific gentlemen, are counsellors. Many of the subscriptions were discontinued during the war, and it is expected that not a few members will resign, owing to the pressure of the times; but an active propagandism is contemplated. The national exchequer being impoverished by the war indemnity, and every scientific expense being curtailed or suppressed, much is to be hoped from private exertions for saving France from scientific degradation. It is rumoured that the laboratories established at the Sorbonne and other public establishments by the Empire during M. Duruy's ministry will be closed for want of money.—M. Sanson, the general secretary, read a report adopted by the council at the meeting of July 18, which was also adopted by the General Assembly. Every member is asked most earnestly to pay at once all the contributions in arrear, and the contributions which become due up to the month of March 1872. In doing so the Association will be enabled to enlarge the field of its opepations, and to start with new life. The Association publishes every month a periodical, which is sent free to all its members, and is sold at the very low price of 2*s.* 6*d.* a year. This periodical publishes the account of the monthly meetings, as well as much scientific news of general interest. It was resolved that the immediate attention of the Association should be devoted to the determination of the reports of the amount of rain in France, a subject of the highest importance for all agricultural purposes; and to the observation of falling stars, a subject not less useful for the science of the constitution of the earth. The meteorological correspondents of the Society are instructed to notice the variations in the distribution of rain, which can be attributed to the presence of woods or their destruction, for agricultural purposes, as well as any facts relating to the pluviometrical history of the country. A special instruction is to be sent to those who have volunteered for the observation of falling stars, everyone is to be qualified by a previous instruction in the knowledge of the constellations. The society published two or three years ago special maps, similar to the maps published by the British Association for the same purpose, but differing in many important details. M. Pierret, the director of the telegraphic lines, has given strict orders that telegraphic lines could be made use of for the comparison of the chronometers used in the stations. The exchange of telegrams will take place on the 9th, 10th, and 11th August, at four o'clock in the evening, and at eight in the morning, between the different places, where temporary observations are to be made. Paris, Evrecy (Calvados), Mans, Chartres, Rochefort, Poitiers, Bordeaux, Limoges, Toulouse, La Guerche, Montpellier, Marseilles, Tournus, Lyons, Barcelonette, Toulon, Nice, Genoa, Turin, Bayonne, Agde: twenty-one stations and several in Italy or in Spain in connection with the French system. Competent calculators are to reduce and compare observations. If the funds of the Society are sufficient, the labours will be paid for. The watch will be kept during the nights from 9-10, 10-11, 11-12. M. Leverrier will revise the calculations, give the proper directions for observations and draw the general report.—M. Bert, who was formerly a prefect at Lille during the investment of Paris, has resumed his labours at the Jardin des Plantes, and read a very able paper on respiration.—M. Dagrou, a photographer, who escaped from Paris by balloon, read a paper on microscopic photograph, which he organised at Tours and at Bordeaux. The photograph is executed on a film of collodion, which he calls a pellicle, and which is lighter than paper; it is, besides, perfectly homogenous, and can be submitted to very powerful instruments. M. Dagrou obtained extraordinary effects, which can be judged from the following facts. Each pellicle has a weight of less than $\frac{1}{20}$ of a gramme, and the matter photographised on it is sufficient to fill from twelve to sixteen folio pages of ordinary print. A single pigeon carries 50,000 messages, weighing less than a gramme. During the investment of Paris 115,000 messages were sent in succession, but several of them were sent fifteen times. The total number of messages sent, counting each repetition a new one, was 2,500,000; of the carrier-pigeons very few found their way to Paris, and these chiefly at the end of the investment. But owing to the repetition system, almost every message was received. Some of them were late, it is true, several carrier-pigeons having returned in February only. Observations are asked for a large bolide of the 19th of July, which might possibly have been observed in England.

BOOKS RECEIVED

English.—A Course of Natural Philosophy: R. Wormell (Groombridge and Sons).—An Elementary Course of Theoretical and Applied Mechanics, 2nd edition: R. Wormell (Groombridge and Sons).

American.—Twentieth Annual Report of the Regents of the University of the State of New York on the Condition of the State Cabinet of Natural History.—Annual Report of the Board of Regents of the Smithsonian Institution, 1869.—Report of the Commissioner of Agriculture for 1869.—Monthly Reports of the Department of Agriculture for 1870.—Reports on the Diseases of Cattle in the United States.

PAMPHLETS RECEIVED

English.—Life and the Equivalence of Force, pt. II.; Nature of Force and Life: J. Drysdale.—On the Undercurrent of the Ocean: Capt. Spratt.—Lisdoonvarna Spas and Sea-side Places of Clare: Dr. Mapother.—Abstract of the Reports of Survey, and of other Geographical Operations in India, 1869-70.—On Recent Investigations and Applications of Explosive Agents: Prof F. A. Abel.—Reply to Prof. Allen Thomson's Address to the British Association (Section D): R. H. Collyer.—Review of the *Lancet's* article on the History of Anæsthetic Discovery: R. H Collyer.—Mysteries of the Vital Element: R. H. Collyer.—John Hampden Triumphant.—A Shilling's Worth of Political Economy: N. A. Nicholson.—Brazilian Republican Address.—Handbook of Devonshire: Exeter.

American and Colonial.—On the Evidence of a Glacial Epoch at the Equator: Prof. J Orton.—The Huron Race and its Head-form: D. Wilson. Note on the Spectrum of the Corona: Prof. C. A. Young.—The Western Educational Review, July.—Embryological Studies on Diplax, Perithemis, and the Thysanurous genus Inostoma: A. S. Packard, junr.—Volcanic Manifestations in New England: W. T. Brigham.—Proceedings, Communication, and Bulletin of the Essex Institute; a parcel.—Proceedings of the Albany Institute, vol. I, pt. I.—In Memoriam Francis Peabody.—On Insects inhabiting Salt Waters, No. 2: A. S. Packard, jun.—Bristle-tails and Spring-tails: A. S. Packard, jun.—List of Insects collected at Pebas, Equador: A. S. Packard, jun.—Early Stages of Ichneumon Parasites: A S Packard, jun.—Morphology and Ancestry of the King Crabs: A. S. Packard, jun.—Embryology of Limulus Polyphemus: A. S Packard, jun.—Catalogue of the Balænidæ of California:—A. S. Packard, jun.

Foreign.—Bulletin Mensuel de la Société d'Acclimatation.—Sulla influenza delle materie minerali, nei processi nutritivi dell' organismo umano: Dr. G. Polli.

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